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(54) **PULVERIZER**

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E04G 23/08 (2006.01)

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(58) **Field of Classification Search** 241/101.73, 241/266, 101.72, 101.71; 30/134
See application file for complete search history.

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(57) **ABSTRACT**

An automatically swiveling crushing apparatus has a swiveling motor in a bracket, and branches diverged from charging and discharging paths that constitute the hydraulic piping leading to a cylinder for closing or opening distal crushing arms. One of the branches extends from one of the paths then operating to open the end arms, so that a portion of the hydraulic fluid is fed to the hydraulic motor if and when internal pressure in this branch has exceeded an upper limit. The other branch extends from the other path leading to the cylinder so as to close the end arms, and this branch prevents any amount of hydraulic fluid from flowing back to the motor. The branches render dispensable a discrete or independent hydraulic piping in a self-propelled platform having a proximal working arm to be connected to the apparatus, saving cost and labor in connecting this arm to the apparatus.

14 Claims, 10 Drawing Sheets

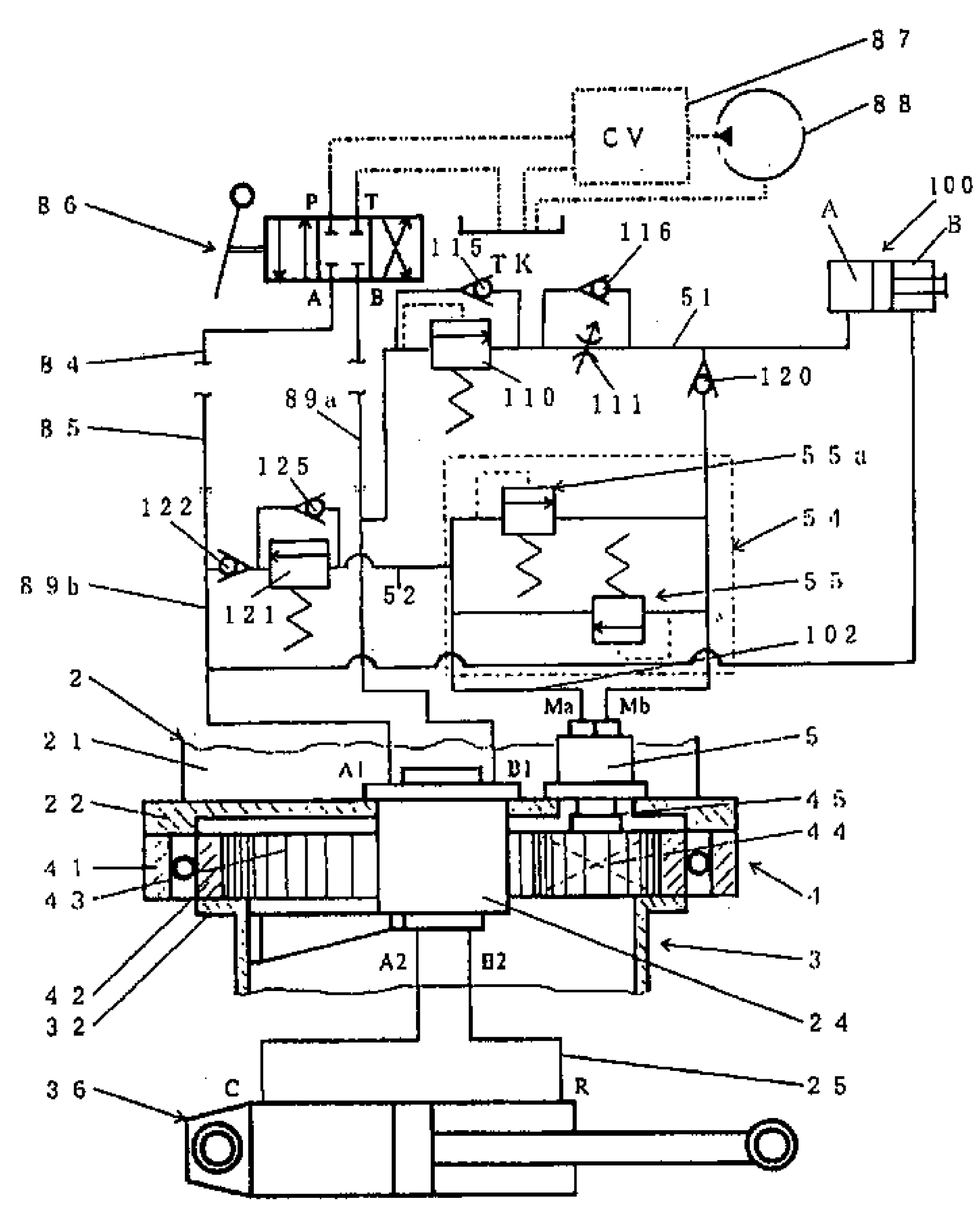

Fig. 1

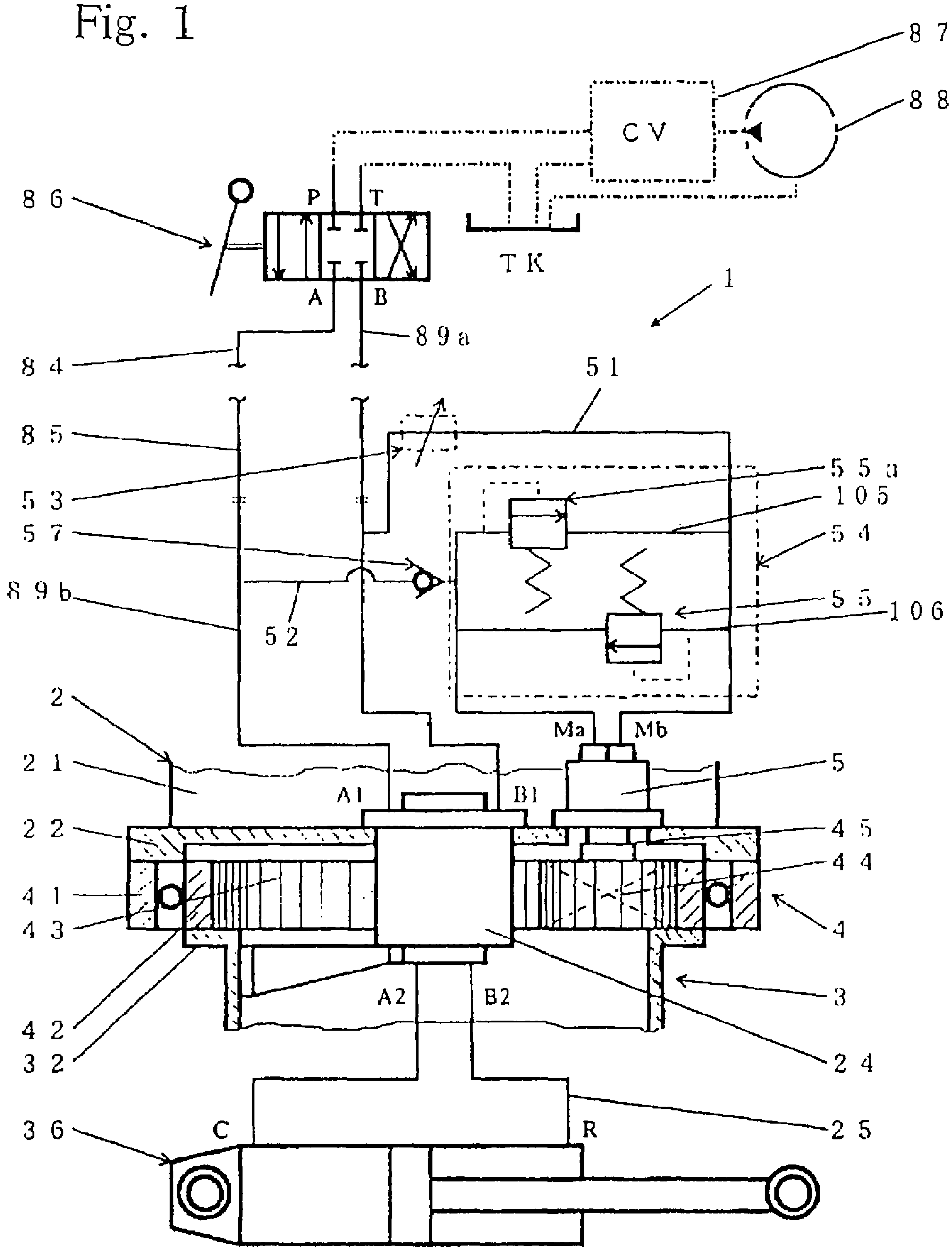
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Fig. 2

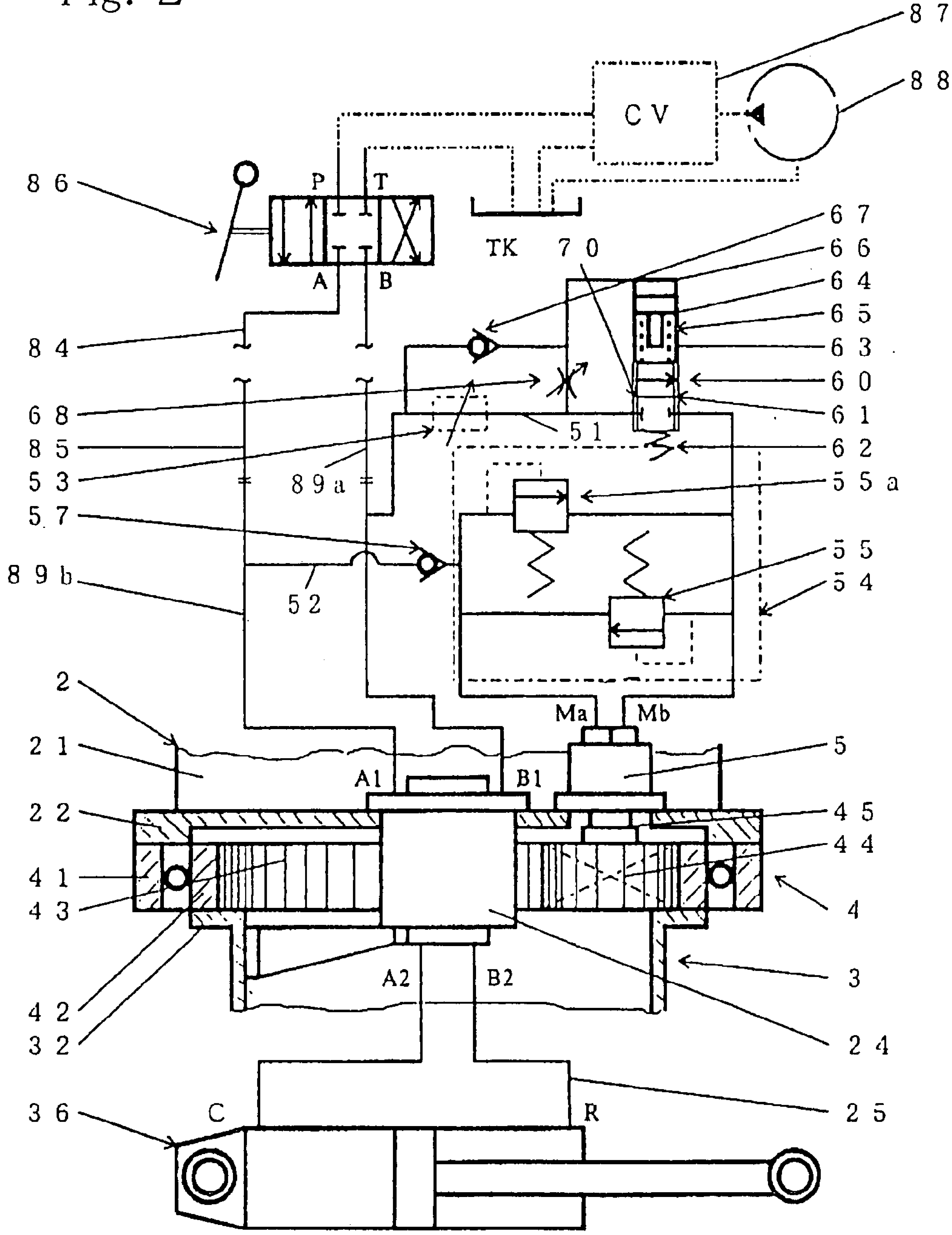

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Fig. 3

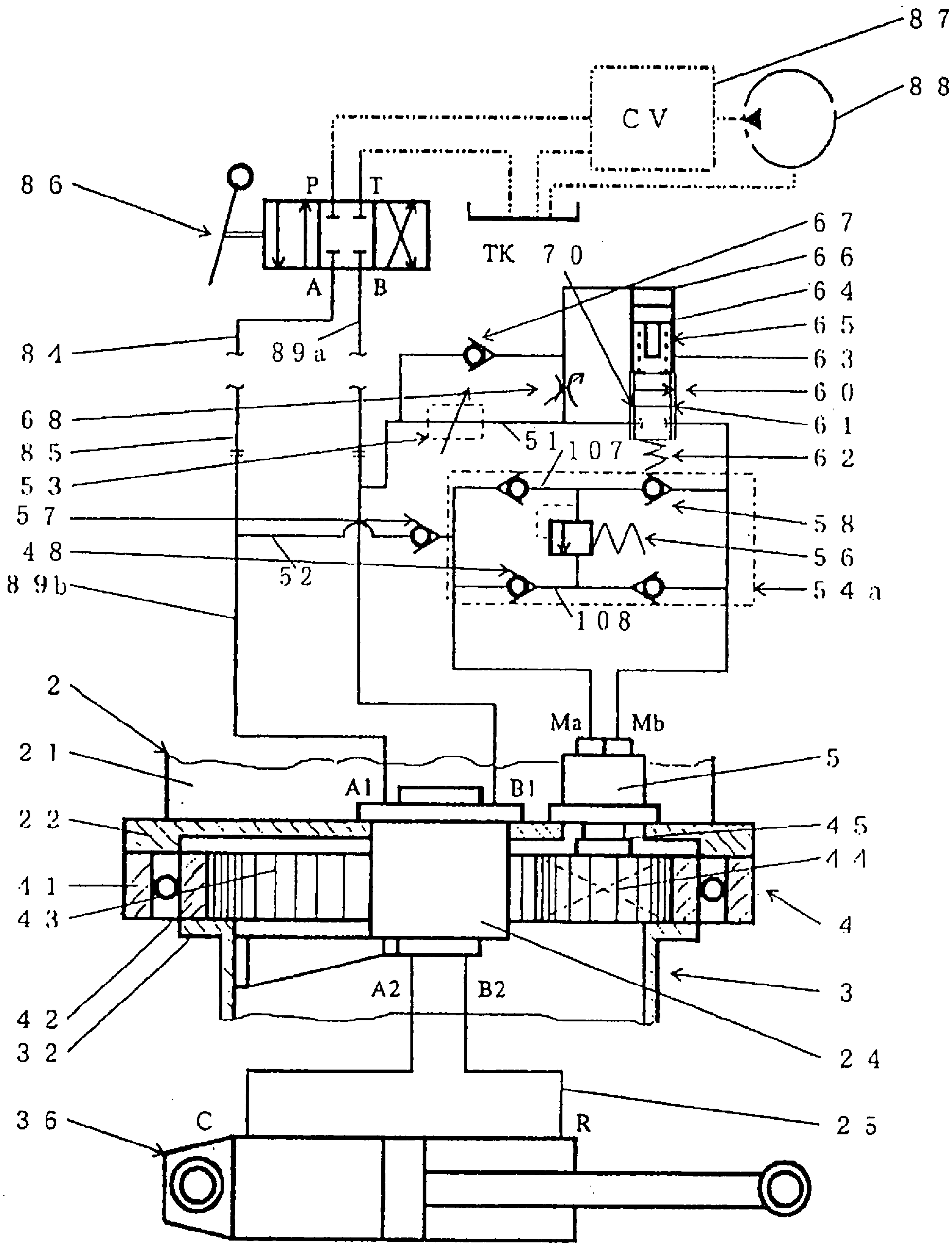

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Fig. 4

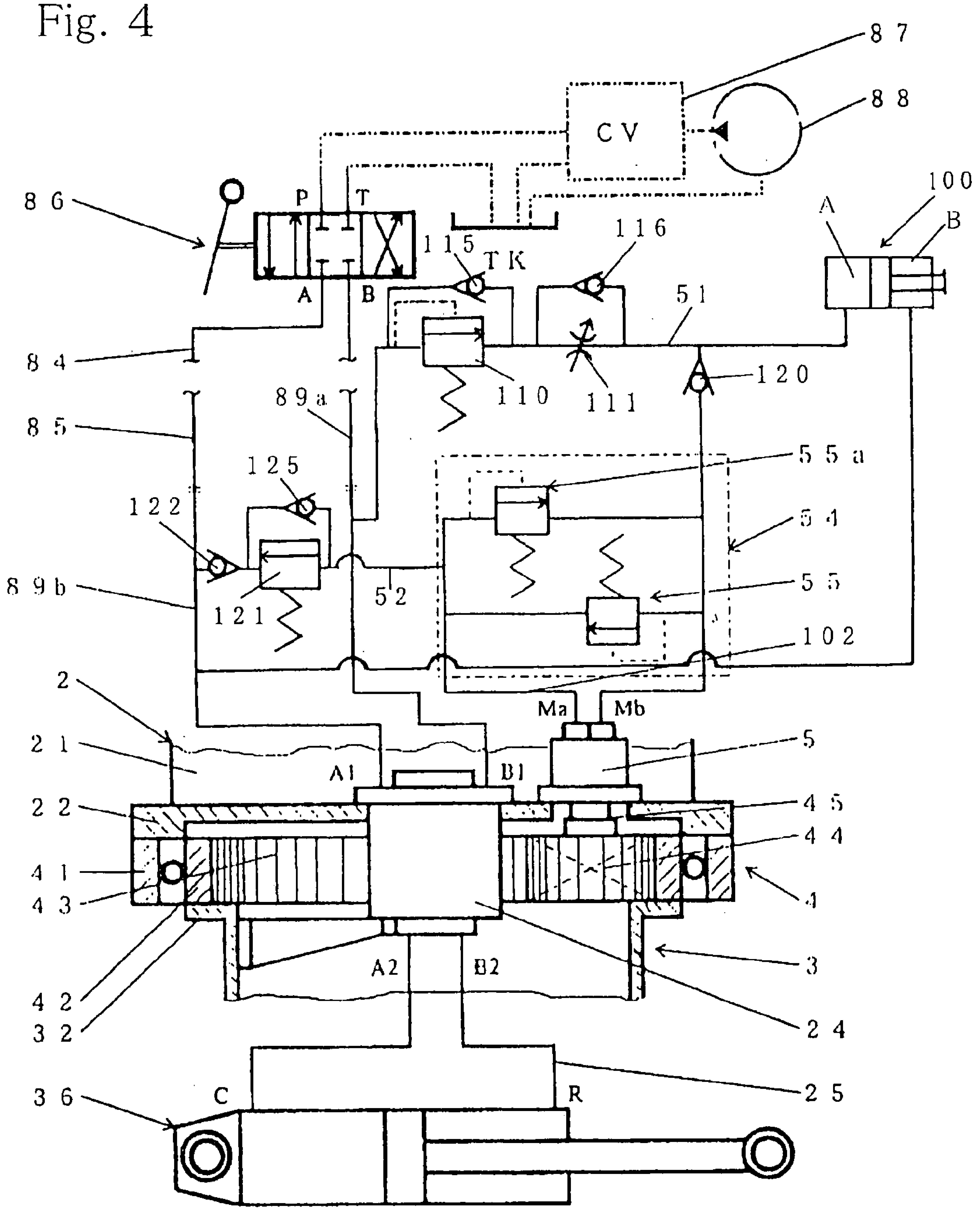
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Fig. 5

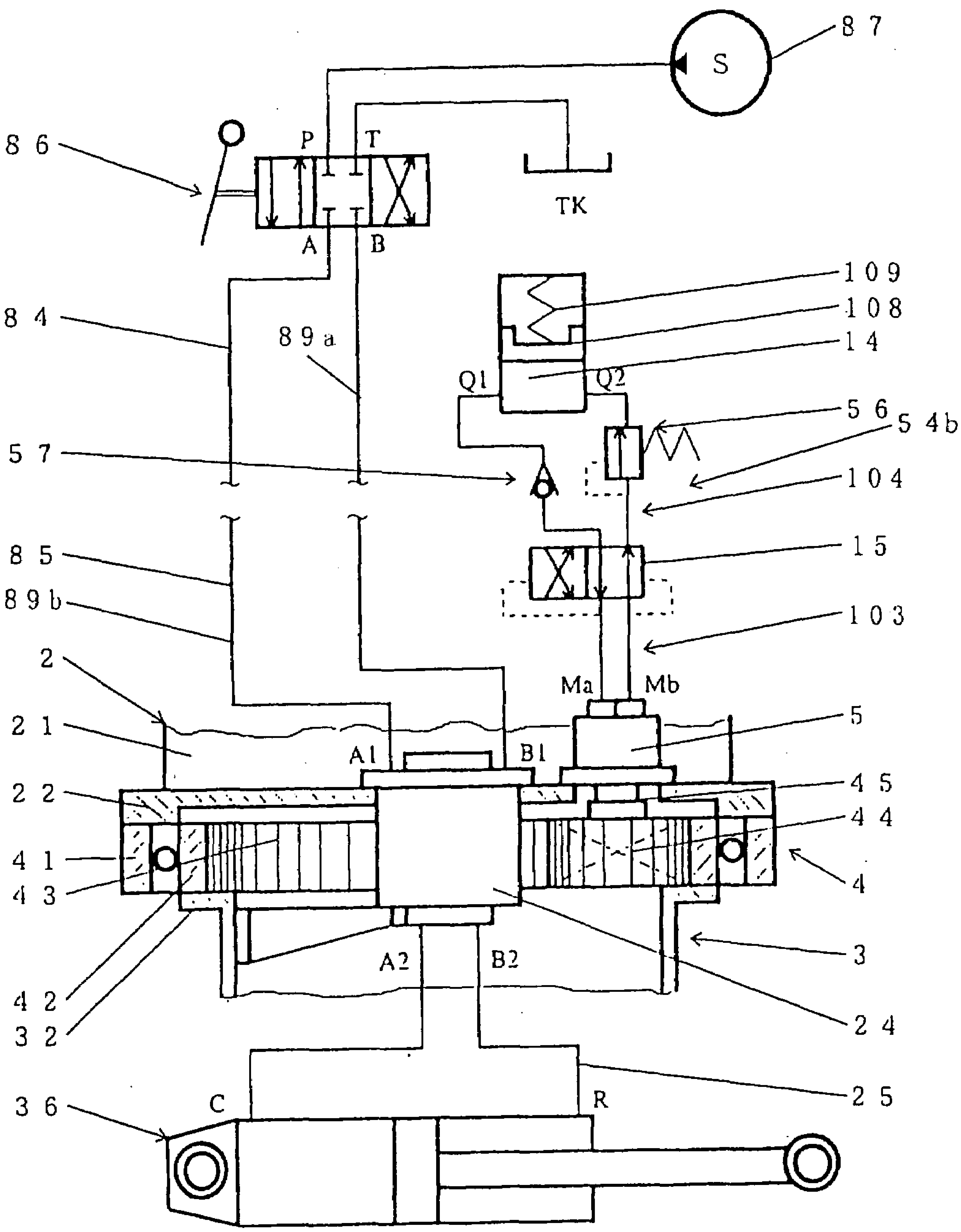
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Fig. 6

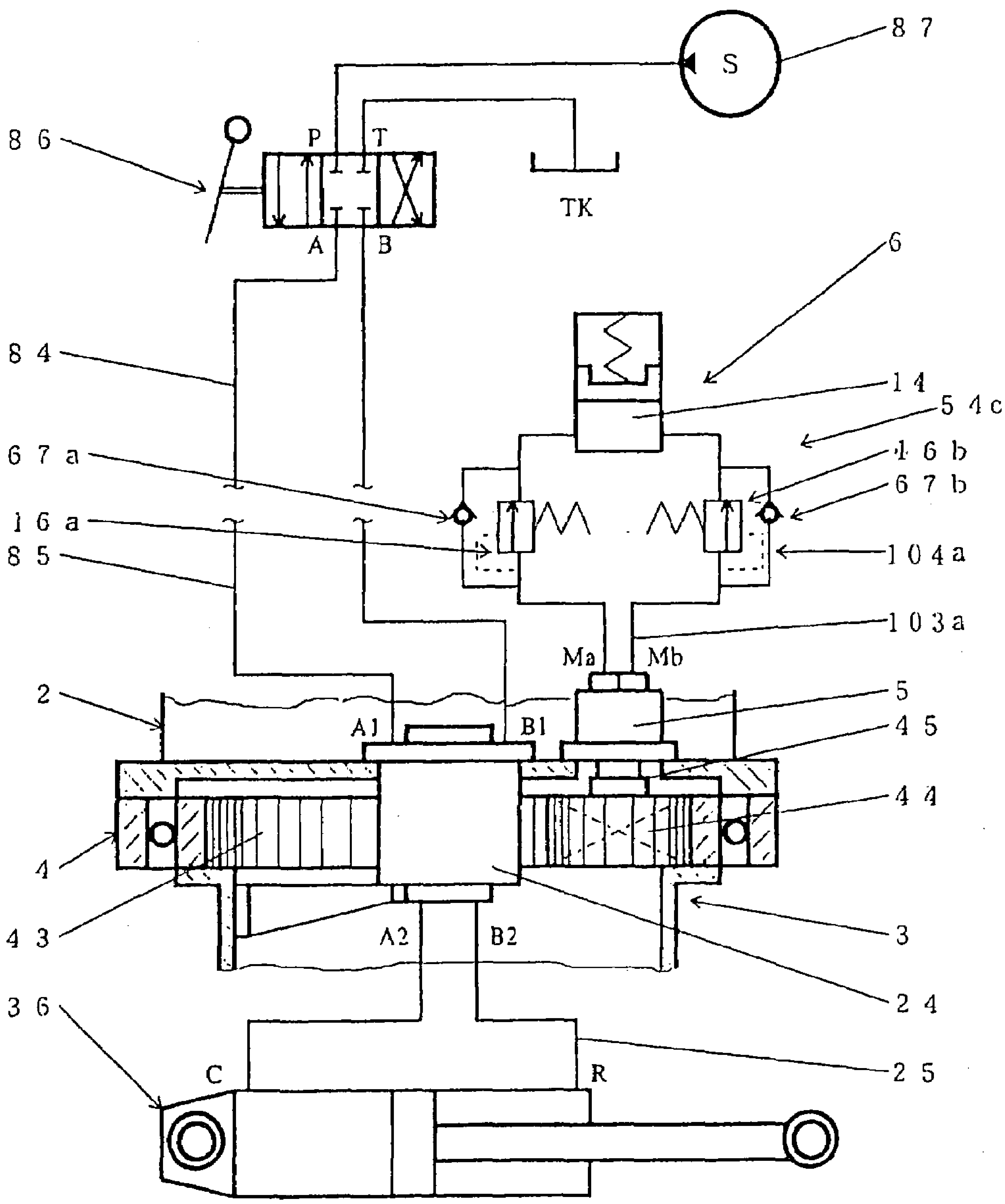
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Fig. 7

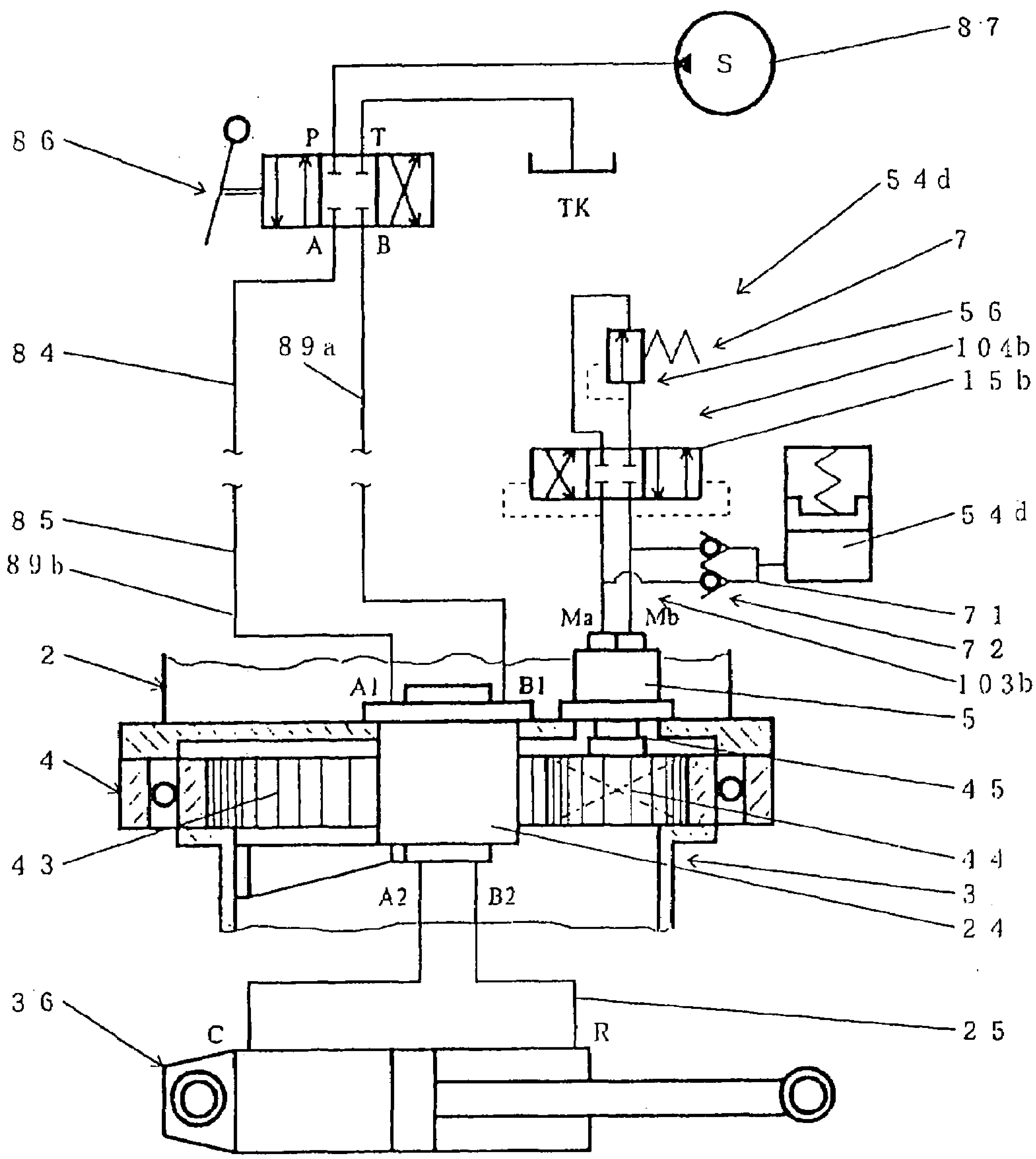
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Fig. 8

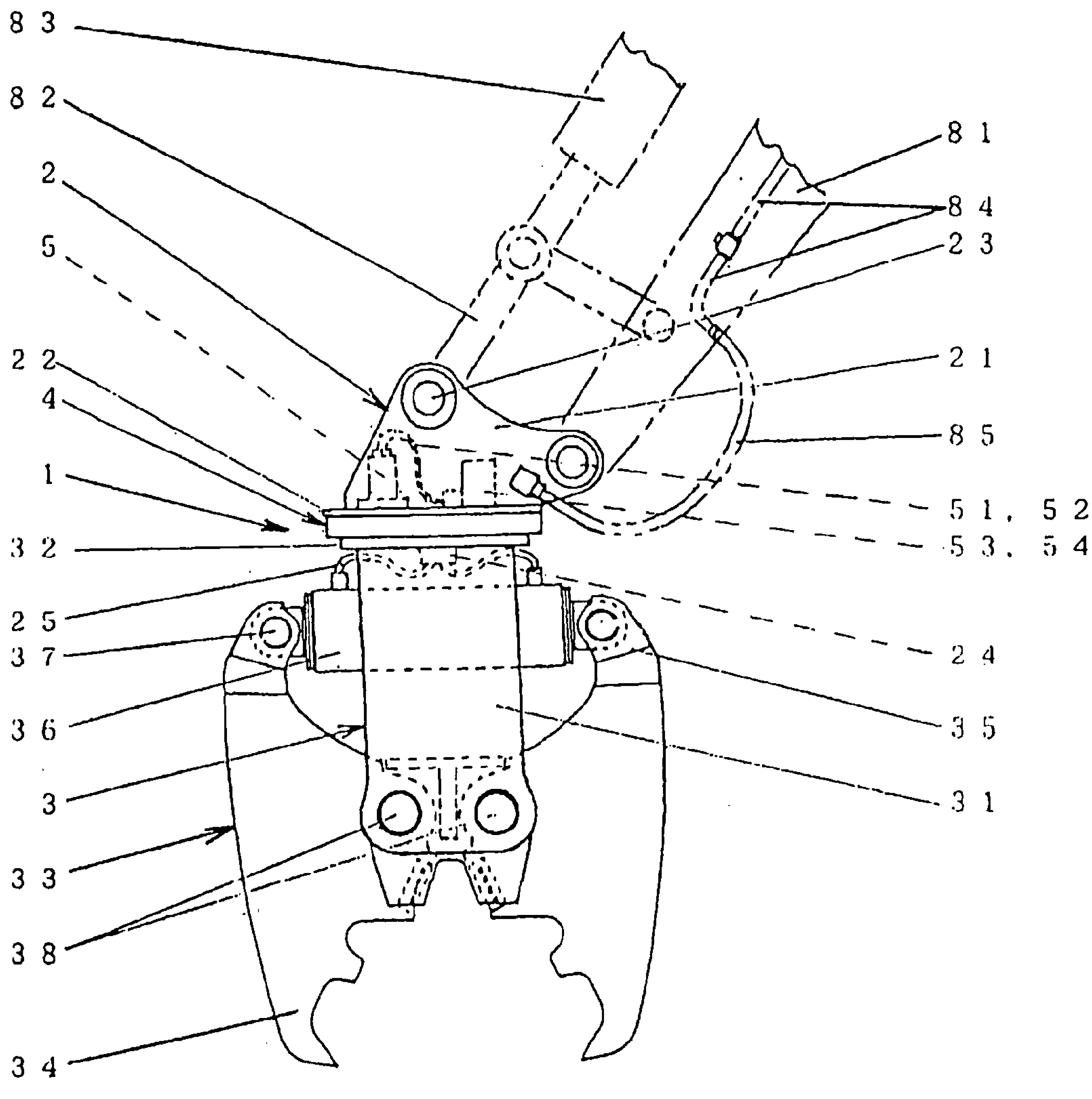


Fig. 9

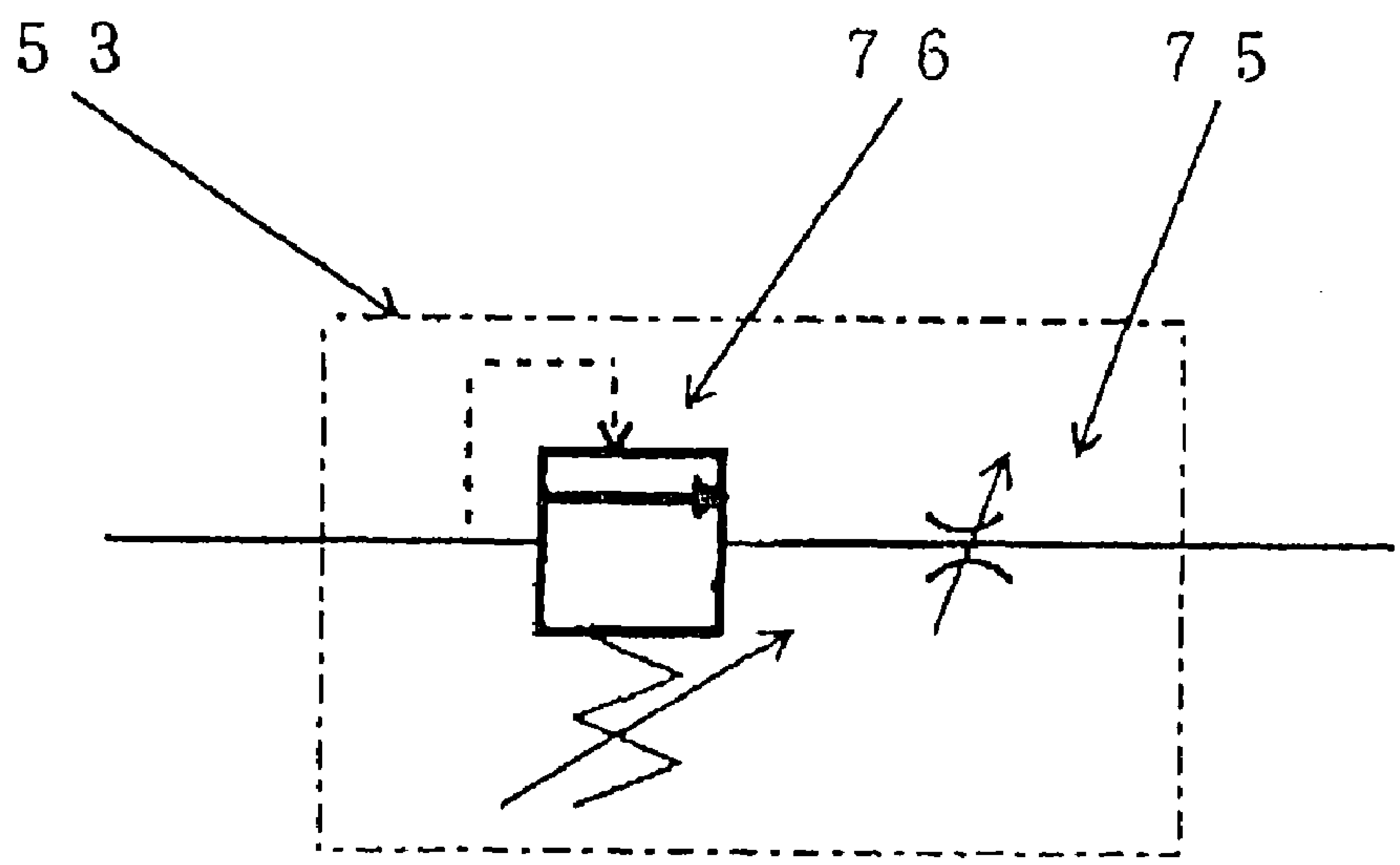
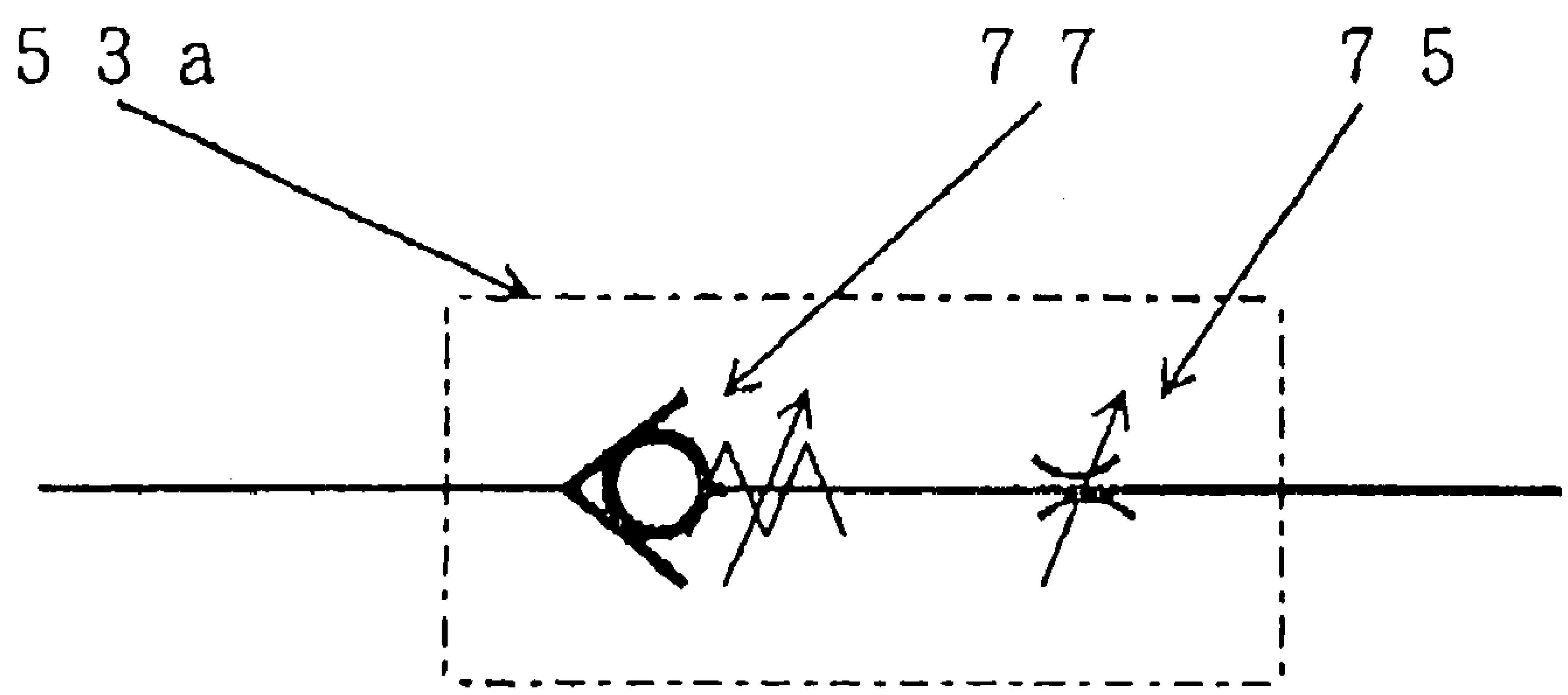


Fig. 10



PULVERIZER

FIELD OF THE INVENTION

The present invention relates to an attachment for use in combination with a construction machinery that is mounted on a self-propelled working platform or truck, and more particularly relates to a crushing apparatus to be mounted thereon.

BACKGROUND OF THE INVENTION

Self-propelled working platforms or trucks such as a hydraulic shovel do generally have attachments connected to the ends of working arms of said platforms. An example of these attachments is a crushing apparatus, which will typically comprise a pair of end arms. Each of the end arms may be shaped as an array of fingers or crab's nails, and a hydraulic cylinder will operate to close or open the end arms.

When a building is demolished using such a crushing apparatus, an operator will have to control its position, posture and/or angular direction in which the pair of end arms are closed or opened, suitably for target article. In order to enable such an operation, those end arms need to swivel as a whole.

For the purpose of turning or swiveling each pair of end arms on the crushing apparatus, they may either be forced to swivel against a braking member to which they are pressed, or be driven automatically by an actuator such as an hydraulic cylinder.

In the former case of forcible swiveling, a crushing apparatus as disclosed in the Japanese Patent Publication No. 7-103700 may for example be used.

A body frame of the crushing apparatus shown in this publication '700 is connected by a swivel bearing to the arm of a power shovel or the like. A disc brake is employed in this case to impart a frictional resistance to the body frame of such crushing apparatus.

Crushing apparatuses of this type are simple in structure, and also advantageous in that any excessively strong torsion acting on each crushing apparatus during its demolishing operation would automatically cause it to rotate in such a manner as protecting it from breakage.

However, it is a disadvantage of this type crushing apparatuses that only those who are highly skilled are allowed to operate them.

Further, a fastening torque for the disc brakes incorporated in such prior art apparatuses is difficult to adjust easily and adequately. Any unintentional rotation resulting from contact with any obstacle or any offset in gravitational center of the crushing apparatus may advantageously be avoided, by selecting a stronger fastening torque for the disc brake. If the torque applied to the disc brake is too intensive, then an excessively strong impact will be needed to swivel the apparatus, thereby incurring an undesirable shock on it and causing its serious damage. A lower fastening torque may be adopted to resolve this problem. However, there will arise another problem that even any weak impact acting on the pair of end arms would be enough to unintentionally rotate them to a wrong angular position, thus lowering efficiency of breaking operations. A friction plate in each disc brake is likely to become worn out soon, impairing its braking effect. The friction plate should be replaced frequently with a new one, so that maintenance works including the adjusting of fastening torque have to be repeated many times.

A proper braking force will be maintained, only if such intricate adjusting and maintenance works are done by well-experienced and highly-skilled operators at considerably short intervals of time.

In the latter case of automatic swiveling, a hydraulic motor or the like has to be installed in the crushing apparatus so that a body frame thereof is operatively connected to said motor.

Discrete hydraulic fluid lines are necessary along the working arm of a hydraulic power shovel, respectively for the hydraulic cylinder for closing and opening the end arms and for the hydraulic motor for swiveling these arms. Distal ends of the two hydraulic fluid lines are adjoined to a hydraulic connector disposed on a bracket of the crushing apparatus, so that an operator within a cabin will use a pedal and/or lever to close or open the end arms and also to swivel same. Thus, the operator can do his work for swiveling the arms more easily by virtue of such a hydraulic system, although a complicated piping and a lot of hydraulic devices are indispensable.

It does not suffice to equip the hydraulic shovel with an oil piping for closing or opening the pair of end arms as the principal parts of a crushing apparatus attached to said shovel. Another piping independent of the said one piping and comprising a control valve, a maneuverable pedal and/or lever should be mounted on the prior art crushing apparatus in order to actuate the hydraulic motor for swiveling the pair of end arms. Thus, two independent oil lines necessary for the closing/opening and swiveling of the pair of end arms will raise material and labor costs in transforming the power shovel. In a case wherein an additional casing drain must be returned to a central reservoir for certain types of hydraulic motors, the material and labor costs will rise further.

DISCLOSURE OF THE INVENTION

The present invention was made to resolve the problems inherent in the prior art crushing apparatuses of the automatic swiveling type. An object of the present invention is therefore to provide a crushing apparatus designed such that a hydraulic circuit for automatically running a hydraulic motor for automatically swiveling a pair of end arms is branched off from a main piping leading to a hydraulic cylinder for closing/opening the pair of end arms. Another object of the invention is to dispense with an additional independent piping for swiveling the arms so as to reduce a transforming cost of the power shovel and to enable quick mounting and dismounting of the crushing apparatus on and off the power shovel.

Still another object of the invention is to smoothly relieve any impactive torsion that would occasionally be imparted to a working crushing apparatus, thus protecting it from breakage.

Yet another object is to provide such an innovated braking mechanism that can apply to a forcible swiveling system in which the end arms are pressed to a braking member. In this mechanism, any mechanical friction such as produced by a disc brake will not be needed, thereby improving durability and reliability of the system, simplifying the maintenance and adjusting works therefor and elongating the time intervals at which these works are to be done.

In order to achieve these objects, a crushing apparatus provided herein does comprise, in addition to a hydraulic cylinder for closing/opening a pair of arms, a hydraulic motor mounted on the apparatus to swivel the arms and branches diverging from a hydraulic piping leading to the cylinder, such that the branch is operatively connected to the motor. In operation for crushing work, the hydraulic fluid will be fed to the cylinder at a full rate. When the arms at their full opened position are to be swiveled, an excessive amount of the hydraulic fluid will be delivered additionally to said cylinder such that a rise in pressure thus produced will cause a part of the excessive amount to be applied to the motor so as to rotate the arms.

In such a crushing apparatus of the invention, the swiveling motor may be disposed in a bracket or the like, and the branches diverge respectively from a pair of charging and discharging paths that constitute the hydraulic piping leading to the cylinder. Basically, one of the branches originates from the charging path leading to an inlet side of the cylinder then operating to open the arms, and the one branch is constructed to forward a portion of the hydraulic fluid to the hydraulic motor if and when an internal pressure in this branch will exceed an upper limit. The other branch originates from the discharging path leading to another inlet side of the cylinder then operating to close the arms, and this branch is constructed to prevent any amount of hydraulic fluid from flowing back towards the motor.

Preferably in the crushing apparatus just summarized above, a relieving throttle valve may be disposed in the one branch originating from the charging path leading to the inlet side of the cylinder then operating to open the arms. A check valve may be disposed in the other branch originating from the other charging path (viz., the discharging path referred to above) leading to the another inlet side of the cylinder then operating to close the arms.

A means for bypassing and buffering any impacting internal pressure may be installed in the branches, and preferably intermediate between the throttle valve and the hydraulic motor or intermediate between the check valve and this motor.

Preferably, the bypassing and buffering means may comprise two parallel bypass lines that are connected each to both the branches and have regulating relief valves respectively disposed therein, with one of them facing counter the other. In an alternative example, check valves may be disposed in the branches, also one of them facing counter the other, so that middle portions between these check valves do communicate with each other through a regulating relief valve.

Alternatively, a pilot switching valve and a resistance device may be used in combination to form such a bypassing and buffering means, wherein this valve senses the fluid pressure at two ports of the hydraulic motor so that the resistance device is caused to communicate with one of the ports where the pressure has risen.

Also alternatively, a one-way resisting device may be disposed in each bypass line such that the hydraulic fluid can freely flow in one direction through the bypass line, but cannot do so in the other direction unless the pressure exceeds a threshold. In a further alternative mode of the bypassing and buffering means, a pilot switching valve may be employed in combination with a relief valve and a check valve that are arranged such that the check valve will open when the fluid pressure is to be relieved. In this case, the pilot switching valve will operate to automatically bring the inlet side of relief valve into communication with one of the hydraulic motor's ports whose pressure has risen.

In addition to the elements mentioned above with respect to the hydraulic circuit, a delay device may be built in one of the branches and downstreamly of the relieving throttle valve so that this branch is opened when a predetermined period of time has lapsed after an amount of hydraulic fluid was urged towards said branch. In this case, delivery of the amount of fluid to the hydraulic motor for swiveling the arms will be delayed a noticeable time after the arms have opened fully.

The delay device may preferably be composed of a switch-over valve having two alternative positions for inhibiting or permitting the flow of hydraulic fluid, a communication path for bringing an inlet port of this valve into a fluid communication with a pilot chamber, and a return path for causing the pilot chamber to communicate with an upstream side of the relieving throttle valve, passing though the check valve. The switch-over valve has a spool installed therein, and this spool has one end in contact with a coiled spring and another end in contact with a biasing means comprising the pilot chamber noted above. The coiled spring will normally urge the spool towards one of the alternative positions where the hydraulic fluid is inhibited to flow. If and when an excessive amount of hydraulic fluid has been forced into the pilot chamber, the spool will be driven to its another position where the hydraulic fluid is allowed to flow.

In particular, the present invention is directed to a crushing apparatus that is attachable to a working arm of a self-propelled platform or truck, and that comprises crushing arms capable of being closed or opened by a hydraulic actuator as well as a swiveling mechanism having a hydraulic motor for driving the crushing arms to swivel. This apparatus further comprises a branch diverged from a hydraulic fluid path communicating with the actuator for closing and opening the crushing arms, with this path feeding the hydraulic fluid to said actuator when the crushing arms are driven to open. Disposed in the branch is an on-off means that normally keeps the branch closed, but will open this branch so as to drive the motor only when a pressure applied to the actuator rises above a predetermined level while the crushing arms remain opened.

Similarly, the present invention is directed to a crushing apparatus that is attachable to a working arm of a self-propelled platform or truck, and that comprises crushing arms capable of being closed or opened by a hydraulic actuator as well as a swiveling mechanism having a hydraulic motor for driving the crushing arms to swivel. This apparatus further comprises, in addition to hydraulic fluid paths respectively continuing to or from the actuator, branches diverged from the respective paths so as to communicate with the motor for swiveling the crushing arms. One of these paths will feed the hydraulic fluid to said actuator then the crushing arms are driven to open. Disposed in one of the branches that is diverged from a hydraulic fluid path for feeding the hydraulic fluid to the actuator when the crushing arms are driven to open is an on-off means that normally keeps this branch closed, but will open it so as to drive the motor only when a pressure applied to the on-off means rises above a predetermined level. A backflow inhibitor is disposed in the other branch so that any amount of the hydraulic fluid cannot flow back towards the hydraulic motor.

A portion of the hydraulic fluid that is flowing to and through the arm closing/opening actuator so as to open the crushing arms to be kept open will thus be fed to the arm swiveling motor. In other words, this motor will never be actuated while the arms remain closed to crush a concrete block or the like.

The on-off means normally continues to keep closed the branch diverged from the main path for the hydraulic fluid flow for closing or opening the arms, unless the pressure applied to the actuator rises above the predetermined level.

By virtue of this feature, the motor for swiveling these arms will not tend to operate when they are just being opened during any normal work.

It will now be apparent that the crushing arms of the present crushing apparatus must be opened at first and be kept open for a while, before they will be swiveled subsequently. The hydraulic fluid will never be applied to the swiveling motor, until the pressure inside the upstream region of the branch rises above the predetermined level to switch on the on-off means so as to open the branch.

The on-off means may be composed of a relief valve and a throttle valve.

This relief valve may preferably be capable of adjusting and regulating its operative pressure.

Preferably, a means for bypassing and buffering any impacting internal pressure may be employed for the arm-swiveling hydraulic motor.

For this purpose, two ports may be formed in the swiveling motor in order to charge it with the hydraulic fluid and also to discharge the fluid from the motor. One, two or more bypass lines normally standing closed may be formed between the two ports, so that when one of the ports shows a pressure above a predetermined value, this port will come into fluid communication with the other port of a lower pressure.

As an alternative to this example, two ports are likewise formed in the swiveling motor as an inlet and an outlet for the hydraulic fluid. However in this case, each of two bypass lines respectively intervening between the two ports have relief valves that are installed in the respective lines but in opposite directions. A check valve may be disposed beside and in parallel with each relief valve so as to constitute a sub-bypass in each bypass line.

In another alternative wherein two ports are formed in the swiveling motor as an inlet and an outlet for the hydraulic fluid, two bypass lines 'A' and 'B' intervene between these ports. A couple of first check valves disposed in one of the bypass lines 'A' may be arranged face-to-face, with a couple of second check valves being arranged back-to-back in the other bypass line 'B'. A relief valve is employed to connect a first intermediate point between the first check valves to a second intermediate point between the second check valves, so that an amount of hydraulic fluid will be permitted to flow from the bypass line 'A' to the other one 'B' when a pressure at the first intermediate point rises above a limit.

Preferably, a delay device may be incorporated in the branch such that when a pressure therein or in the main hydraulic path has exceeded a limit and a given period of delay time has lapsed, an amount of hydraulic fluid will be supplied to the swiveling motor.

The on-off means in connection with the delay device is composed of a relief valve and a throttle valve, and the delay device itself may preferably be composed of a switch-over pilot valve, a communication path and a return path. The pilot valve has two alternative positions for inhibiting or permitting the flow of hydraulic fluid, and the communication path for bringing an inlet port of this valve into a fluid communication with a pilot chamber. The return path causes the pilot chamber to communicate with an upstream side of the relieving throttle valve, passing though the check valve. The switch-over valve has a spool that remains urged towards one of the alternative positions where the hydraulic fluid is inhibited to flow. If and when an excessive amount of hydraulic fluid has been forced into the pilot chamber, the spool will be driven to its another position where the hydraulic fluid is allowed to flow.

The delay device may alternatively be an additional hydraulic cylinder connected in parallel to the swiveling hydraulic motor.

It is necessary for the additional cylinder to be actuated at a pressure lower than that at which the swiveling motor is actuated.

From a viewpoint of safety afforded by bypassing any impacting pressure, the invention provides a crushing apparatus that is attached to a working arm of a self-propelled platform or truck, and that comprises a fixed race, a movable race cooperating therewith to form a freely swiveling mechanism, a swiveling hydraulic motor, two ports formed in the swiveling hydraulic motor as an inlet and an outlet, both for the hydraulic fluid, and at least one bypass line intervening between these ports. The apparatus further comprises a bearing race-side gear and a motor-side gear engaging therewith such that the former gear operates in unison with the movable race, with the latter gear rotating in unison with the motor, wherein the at least one bypass line normally standing closed is to be opened when one of the ports shows a pressure above a predetermined value, so that the one port will come into fluid communication with the other port of a lower pressure.

As an alternative to this example, two ports are likewise formed in the swiveling motor as an inlet and an outlet for the hydraulic fluid. However in this case, two bypass lines intervening between the two ports have relief valves that are installed in the respective lines but in opposite directions. A check valve may be disposed beside and in parallel with each relief valve so as to constitute a sub-bypass in each bypass line.

In another alternative wherein two ports are formed in the swiveling motor as an inlet and an outlet for the hydraulic fluid, two bypass lines 'A' and 'B' intervene between these ports. A couple of first check valves disposed in one of the bypass lines 'A' may be arranged face-to-face, with a couple of second check valves being arranged back-to-back in the other bypass line 'B'. A relief valve is employed to connect a first intermediate point between the first check valves to a second intermediate point between the second check valves, so that an amount of hydraulic fluid will be permitted to flow from the bypass line 'A' to the other one 'B' when a pressure at the first intermediate point rises above a limit.

A pilot switching valve may be incorporated in the at least one bypass line in combination with a resistance device. In this case, the valve will sense the fluid pressure at two ports of the hydraulic motor so that the resistance device is caused to communicate with one of the ports where the pressure has risen.

Also preferably, a one-way resisting device may be disposed in each bypass line such that the hydraulic fluid can freely flow in one direction through the bypass line, but cannot do so in the other direction unless the pressure exceeds a threshold. Both the one-way resisting devices will allow portions of the hydraulic fluid to flow towards the motor, but inhibit these portions from flowing in counter directions.

Alternatively, a pilot switching valve may be employed in combination with a relief valve and a check valve that are arranged such that the check valve will open when the fluid pressure is to be relieved. In this case, the pilot switching valve responsive to pressure at each of the ports will operate to automatically bring the inlet side of relief valve into communication with one of the hydraulic motor's ports whose pressure has risen.

Preferably, a compensation means may be disposed in either or each bypass line. This means will operate to maintain the amount of hydraulic fluid in the bypass line neither too much nor too less.

A hydraulic fluid reservoir may be used as the compensation means.

It is preferable to employ a compressing means to compress always the hydraulic fluid stagnant in the reservoir.

Such a compensation means may be arranged either in series to or in parallel with the bypass line.

From a still further point of view, the present invention provides an attachment for use in a construction machinery, and this attachment may be adapted for connection to a working arm mounted on a self-propelled working platform or truck that has a hydraulic-pressure-generating equipment. The attachment comprises a swiveling mechanism such that a hydraulic swiveling actuator will rotate the attachment. The attachment further comprises a branch that diverges from a main path connected to another hydraulic actuator so that the swiveling actuator receives a flow of hydraulic fluid through the branch. The attachment further comprises an on-off means, disposed in the branch, that will open this branch so as to drive the swiveling actuator only when a pressure in the main path rises above a predetermined level.

An example of such an attachment may be a crushing apparatus having crushing arms, wherein the another actuator is a hydraulic cylinder that closes and opens the arms.

The branch preferably may diverge from a portion of the main path feeding the hydraulic fluid to open the crushing arms.

An example of the swiveling actuator may be a hydraulic motor.

From a yet still further point of view, the present invention provides an attachment for use in a construction machinery, and this attachment may be adapted for connection to a working arm mounted on a self-propelled working platform or truck. The attachment comprises a hydraulic motor as well as a swiveling mechanism in an operative connection therewith. The attachment further comprises at least one bypass line normally standing closed and connected to two ports, one functioning as an inlet and the other as an outlet of the hydraulic fluid fed to the motor. The bypass line will open when one of the ports shows a pressure above a predetermined value, so that the one port will come into fluid communication with the other port of a lower pressure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a first embodiment of the present invention;

FIG. **2** is another diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a second embodiment;

FIG. **3** is still another diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a third embodiment;

FIG. **4** is yet still another diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a fourth embodiment;

FIG. **5** is a further diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a fifth embodiment;

FIG. **6** is a still further diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a sixth embodiment;

FIG. **7** is a yet still further diagram of a hydraulic circuit including relevant parts and operating for a crushing apparatus provided in a seventh embodiment;

FIG. **8** is a front elevation of the crushing apparatus provided herein;

FIG. **9** shows a fragmentary hydraulic circuit including a relieving throttle valve; and

FIG. **10** also shows a likewise fragmentary hydraulic circuit including the relieving throttle valve in a modified type.

BEST MODES OF CARRYING OUT THE INVENTION

An auto-swiveling crushing apparatus of the invention must comprise at least one hydraulic motor **5**. This motor **5** operates to drive the crushing apparatus to swivel in the first to fourth embodiments, whilst it operates to brake the crushing apparatus swiveling in the fifth to seventh embodiments.

There are two types of crushing apparatuses, and one of them is the double-acting type shown in FIG. **8**. In this case, a frame is rotatably connected by a swiveling bearing to a bracket, so that a pair of swingable crushing arms are pivoted to the frame. Although a single-acting type of the crushing apparatus is not shown, its frame is likewise rotatably connected by a swiveling bearing to a bracket. However, its fixed arm protrudes forwards from the frame and a swiveling arm is pivoted to a basal portion of the frame so as to face the fixed arm.

The crushing apparatus **1** shown in FIGS. **1** and **8** comprises the swiveling hydraulic motor **5**. The motor **5** is fixed on a horizontal plate **22** of the bracket **2**, though it may otherwise be secured to the bracket itself or to the frame. An inner race **42** of the swiveling bearing for this crushing apparatus **1** is fixed on the frame **3**, and a circular rack **43** is engraved in the inner periphery of said inner race **42**. A pinion **44** in mesh with the rack **43** is fixed to a shaft of the hydraulic motor **5**. If the motor **5** is fixedly attached to the bracket **2**, then a pair of crushing arms **33** and the frame **3** will rotate horizontally and relative to the bracket **2** when the motor **5** rotates.

Branches **51** and **52** leading to the swiveling motor **5** disposed in the bracket **2** are diverged respectively from forward or rearward main hydraulic paths **89***a* and **89***b*, that are connected to a hydraulic cylinder **36** for closing or opening the arms. When the arms are to be opened, the main path **89***b* will feed a hydraulic fluid (for example, oil) to the cylinder, with the other main path **89***a* feeding the hydraulic fluid when the arms are to be closed. A relieving throttle valve **53** is disposed in the branch **51** diverging from the arm-opening path **89***b*, and a check valve **57** is disposed in the other branch **52** from the arm-closing path **89***a*. An impacting-pressure bypassing means **54** (enclosed with a dot-and-dash line) intervenes between the branches **51** and **52**. Particularly, this means **54** is disposed between the throttle valve **53** and one of hydraulic ports (Mb) of the motor **5**, and also between the check valve **57** and the other port (Ma).

As shown in the hydraulic circuit of FIG. **2** or **3**, a retarding means **60** for causing a delayed or interrupted opening of a hydraulic passage may be incorporated between the throttle valve **53** and motor **5**. This means **60** will open the passage when a given length of time will have lapsed after the branch **51** leading to the motor **5** began to receive a hydraulic fluid flow. The opening motion of a switch-over valve **70** as a principal part of the retarding means **60** may be delayed to any desired extent by enlarging the volume of a pilot chamber **66**, increasing a gap between a piston **64** and a spool **61**, and/or constricting a throttle **68**.

In place of the retarding means **60** shown in FIGS. **2** and **3**, another type of retarding means **100** consisting of a non-loaded or light-loaded cylinder may be employed such that it stands parallel with motor **5** as seen in FIG. **4**.

The composite relieving throttle valve **53** may be formed, as shown in FIG. **9**, of a variable throttle **75** and a variable relief valve **76** connected in series thereto as in the prior art. Alternatively, the throttle valve **53***a* may be formed of the variable throttle **75** and a check valve **77** whose cracking pressure is variable, as shown in FIG. **10**. In any case, the throttle valve **53** will effect its relieving function if and when the fluid pressure in the cylinder **36** will have been boosted after the cylinder stopped at a point for fully opening the crushing arms **33**. The branch thus opened will function to feed a hydraulic fluid flow to the motor **5**, at an appropriate flow rate which the throttle valve **53** is then controlling.

The impacting-pressure bypassing means **54** is composed of bypass lines **105** and **106** arranged in parallel with each other and both extending be-tween the branches **51** and **52**. Variable relief valves **55** and **55***a* respec-tively disposed in these bypass lines **106** and **105** do face in opposite directions one against another. FIG. **3** shows an alternative example of the impacting-pressure bypassing means **54***a* comprising an fluid passage **107** (bypass line 'A') and another one **108** (bypass line 'B') between the branches **51** and **52**. The passage **107** communicates with a higher-pressure side through a pair of first check valves **58**, with the other passage **108** communicating with a lower-pressure side through a pair of second check valves **48**. A bridging path provides a fluid communication of a intermediate point between the first check valves **58** with another intermediate point between the second ones **48**. A variable relief valve **56** is disposed in this communication path, in a direction from the higher-pressure side to the lower-pressure side.

The impacting-pressure bypassing means **54** or **54***a* will function to relieve to the lower-pressure side an impacting excessive or extreme pressure that may appear on the higher-pressure side when the swiveling motion stops or any accidental overload happens. Thus, even if such an impacting pressure would appear in either one of fluid paths **89***a* and **89***b*, it will be relieved to the other path so as to protect the motor and the other hydraulic devices from breakage.

In alternative modes, any of the impacting-pressure bypassing means **54***b*, **54***c* and **54***d* may be employed instead of using those noted above. In the bypassing means **54***b* of FIG. **5**, a bypass line **103** connects an inlet port Ma to an outlet port Mb of motor **5** in fluid communication with the inlet port. A pilot switch-over valve **15** is disposed in the bypass line **103** as seen in FIG. **5**, in such a manner that the ports Ma and Mb are connected to respective valve ports corresponding to opposite ends of a spool of the valve **15**. In the event that the motor **5** would be forced to rotate to an excessive extent, it will automatically be judged which port is then on a suction side or on an exhaustion side. Connected to the exhaustion side port (for instance Mb) via the pilot switch-over valve are a variable relief valve **56** (as a resistance), a fluid reservoir **14** and a check valve **57**, in this order. Thus, a relieved amount of hydraulic fluid will flow back through the valve **15** and suction side port (for instance Ma) and return into the hydraulic motor **5**.

The structure illustrated in FIG. **5** is an alternative mode such that the crushing end arms are pressed against a foreign obstacle so as to be forced to rotate, wherein the hydraulic motor **5** is used as a resistance or brake acting against such a forced rotation.

In this case shown in FIG. **5**, a torsion stress will be imparted to the crushing apparatus that has gripped a target article and is then forcibly swiveling, with its end arms being pressed on any other article. Consequently, the motor **5** will receive a torque through the pinion **44** in mesh with the circular rack **43** of the swiveling bearing **4**. The exhaustion side port Mb of the motor **5** will then exert a pressure to automatically change the position of switch-over valve **15** so as to communicate with the variable relief valve **56**. As the pressure applied to the relief valve **56** rises above a limit, it will relieve a flow of hydraulic fluid into the bypass line, whereby the motor **5** starts to rotate causing the frame **3** of crushing apparatus **1** to swivel against a certain braking force.

The pilot switch-over valve **15** is exemplified in FIG. **5** as a two-position four-way valve enabling a parallel connection and a crossed connection. However, it may have a middle full closed position to be of a three-position four-way type as seen in FIG. **7**, wherein the check valve **57** (in FIG. **5**) is dispensed with.

The bypass line for hydraulic motor **5** may not necessarily be formed in the manner as described above, but be modified in many ways as exemplified in FIG. **6**. In this example, the suction and exhaustion ports of motor **5** are connected respectively to variable one-way resisting means each consisting of a variable relief valve **16***a* or **16***b* and a check valve **67***a* or **67***b* disposed in parallel therewith. These check valves permit a fluid flow towards the motor only. Distal ends of such one-way resisting means may communicate with each other via a fluid reservoir **14**. Although the pilot switch-over valve of FIG. **5** is dispensed with in this case, the variable relief valve **16***a* or **16***b* in either resisting means will exert a resistance against a flow from one Mb of the motor's ports, which is then acting as an exhaustion port. In harmony with this, the check valve in the other resisting means will allow the hydraulic fluid to freely return to the motor through the suction port Ma.

Also alternatively, a hydraulic circuit as shown in FIG. **7** may be employed wherein a pilot switch-over valve **15***b* is used to automatically determine which of the suction and exhaustion ports of motor **5** is then functioning as a higher-pressure port. The higher-pressure port of the switch-over valve **15***b* will consequently be directed through a variable relief valve **56** to the lower-pressure port of this valve **15***b*. A bypass line **103***b* communicating with both the motor **5** and valve **15***b* does comprise a pair of fluid-replenishing paths **71**, **71** each having disposed therein a check valve **72**. These check valves **72** will prevent the high-pressure hydraulic fluid from flowing back into the chamber **54***d* of a discrete fluid reservoir **14**, though the motor's ports are in communication with the fluid-replenishing paths **71**.

Expansion/shrinking or leakage due to change in environmental temperature, as well as compression of a hydraulic fluid, may cause an excess or deficiency in the amount of fluid in the bypass line **103***b*. The fluid reservoir **14** communicating with this bypass line will compensate any excess or deficiency almost completely. However, a compressing means may preferably be incorporated in the reservoir **14** in order that deficiency is more surely compensated to avoid cavitation.

As is illustrated in FIGS. **5**, **6**, **7**, the compressing means may comprise a piston **108** fitted in a cylinder and having a rear face urged forwards by a spring **109**, thereby compressing the fluid within the chamber (of reservoir **14**). This spring may be replaced by an amount of proper gas, or alter-natively a flexible plug containing an amount of gas sealed therein may substitute for the combination of piston **108** and spring **109**.

Generally in operation of each of the crushing apparatuses **1** shown in FIGS. **1** to **4**, a maneuverable control valve **86** may be shifted at first to its crossed flow position so that a hydraulic fluid flow will be delivered from one of ports 'B' of this valve to a swivel joint **24**. This will then advance through said joint **24** and to enter the arm-closing/opening cylinder **36**, through its port 'R' opened to face a piston rod fitted in this cylinder. While the piston rod is thus being retracted to open the crushing end arms **33** and **33**, without encountering any resisting load, the pressure of hydraulic fluid will remain low enough to keep closed the relieving throttle valve **53** in the hydraulic circuit for the swiveling motor **5**.

After the arms have opened fully, the pressure of hydraulic fluid flow from the control valve will start to rise so that the relief valve **76** (see FIG. **9**) in the throttle valve assembly **53** is consequently opened. As a result, the branch **51** leading to the port Mb of the motor **5** will be supplied with the hydraulic fluid, driving the motor **5** to swivel the arms **33** of this crushing apparatus **1**. The variable throttle valve **75** in said valve assembly **53** will regulate the rate of hydraulic fluid flowing into the motor **5** so as to make it rotate at a moderate speed. On the other hand, the other port Ma of the motor **5** communicates with the return path **89** from the cylinder **36**, through the check valve **57** in the other branch **52**. Therefore, the returning fluid effluent from the motor **5** will advance from the port Ma to a tank 'TK', via port 'A' of the maneuverable control valve **86**.

Upon swivel of the arms **33** to a desired angle, the maneuverable control valve **86** will be shifted to its neutral position in order to stop the flow of hydraulic fluid through this valve, thereby stopping swiveling of the arms. Next, the working platform or truck will be operated in such a manner that its crushing apparatus **1** have the arms **33** engaged with a building's portion to be broken. Then, the maneuverable control valve **86** will be shifted to a parallel flow position so that the hydraulic fluid flows out of the port 'A' of this valve and into the cylinder **36** through its head-side port 'C'. As a result, the piston rod of this cylinder will extend out to close the arms **33**, causing same to crush the building's portion. In spite of a rise in the hydraulic pressure during this process, the check valve **57** will inhibit the fluid from flowing towards the motor **5**, so as to prevent it from rotating.

Further, the crushing apparatus's arms will be driven by the maneuverable valve **86** to repeat their closing and opening motions, so as to accomplish the crushing operation. If the valve **86** is operated to shift back to its neutral position or further to its parallel flow position just after or just before the full opening of arms **33**, any feed of hydraulic fluid to the motor **5** will be interrupted not to rotate them at all.

It is possible that an abnormally high (shocking) pressure appearing in the hydraulic circuit in stopping the motor **5**, or an extreme torsion from which the apparatus **1** suffers during its crushing operation, might cause a shock to the motor or charge it with an excessive load. In this event, the impacting-pressure bypassing means **54** will operate to relieve such an abnormally high pressure to the lower-pressure side. Whether the port Ma or the port Mb does stand then on the higher-pressure side, the variable relief valve **55** or **55***a* will relieve the high pressure from the former to the latter port, or vice versa. Thus, the motor **5** and other devices are protected well from any possible shock or overload.

As seen in FIG. **2**, the retarding means **60** may be incorporated in the hydraulic circuit. In this case, the switch-over valve **70** continues interruption of the circuit for a certain period of time after the throttle valve **53** will have enabled fluid circulation therethrough. The motor is thus prevent-ed from commencing its rotation simultaneously with the opening of said throttle valve **53**. In the retarding means **60**, a narrow throttle **68** will direct a hydraulic fluid flow to the pilot chamber **66** at a gentle rate, until the amount of fluid thus accumulated in this chamber does push the spool **61** to open switch-over valve **70**. This means that the arms **33** of the crushing apparatus **1** do begin their swivel late a little after they have opened fully. If the arms need not to swivel, then the maneuverable valve **86** may be shifted to its neutral position before the fluid starts to circulate through retarding means **60**.

As shown in FIG. **4**, the retarding means **100** of a cylindrical type may be employed instead of using that **60** discussed above. In this case, the hydraulic fluid will flow preferentially into the cylinder functioning as said means **100**. One of its expansible chambers is thus filled at first with the fluid to fully extend outwards, so that the fluid will subsequently be fed to the hydraulic motor **5**. Also in this case, the switch-over valve continues interrupt-ion of the circuit for a certain period of time after the throttle valve will have enabled fluid circulation therethrough. The motor **5** is thus prevented from commencing its rotation simultaneously with the opening of said throttle valve.

With the maneuverable valve **86** being shifted to its neutral position or to its parallel flow position (for closing the arms), the check valve **57** will interrupt the fluid feed to the motor **5**. In a case wherein the retarding means **60** is incorporated, its pilot chamber **66** will communicate backwards with the return path **89***a* through the check valve **67**, thereby making switch-over valve **70** restore its home position to more surely prevent fluid feed to the motor **5**.

Embodiments now detailed below will make more apparent the invention, but not restricting its scope. As exemplified in FIG. **8**, the crushing apparatus **1** comprising the hydraulic circuit as discussed above does have the pair of crushing arms **33**, whose middle portions are pivoted at respective pins **38** to the frame **3**. Proximal ends of crushing arms **33** are connected by further pins **37** to the hydraulic cylinder **36**, such that distal ends of said arms are closed towards or opened away from each other as the piston rod of this cylinder **36** is extended or retracted.

The crushing apparatus **1** may be mounted on a hydraulic power shovel body (not shown) having a working arm **81** and a hydraulic cylinder **83** disposed thereon. A piston rod of this cylinder operatively connected to the apparatus **1** through a bucket link **82** will be extended or retracted to swing the apparatus **1** fore and aft to take any desired angular position. As will be seen in FIGS. **1** and **4**, the fluid feed and return paths extend from a hydraulic source **88** and pass through the maneuverable valve **86** so as to form a pair of external pipes **84** continuing to a pair of respective proximal hoses **85**. These distal hoses in turn continue to respective internal paths **89** disposed in the bracket and penetrating the swivel joint **24**. This joint is disposed centrally of the swivel bearing **4**, and the internal paths **89** continue to respective distal hoses **25** connected to the hydraulic cylinder **36**. Thus, a series of forward fluid circuit segments start from the source **88** and reach the cylinder, whilst another series of rearward and complementary segments start from the cylinder so as to return to the tank 'TK'. The source **88** of hydraulic fluid is used also as a power source for driving the power shovel body (though not shown) and is connected by a main control valve 'CV' (**87**) to the maneuverable valve **86**. The latter valve **86** that may be operated using a pedal (not shown) disposed in an operator cabin is a three-position four-way valve having the neutral position, the parallel flow and crossed flow positions. The hydraulic fluid that will be fed through the thus operated maneuverable valve **86** to the cylinder **36** does act to extend out or retract back its piston rod, thereby closing or opening the crushing arms **33**.

The frame **3** for the crushing apparatus **1** is composed of a horizontal top plate **32** and a pair of vertical side walls **31** secured thereto and depending therefrom. The bracket **2** overlying such a frame **3** is composed of a pair of side plates **21** fixed on a horizontal bottom plate **22**, and each side plate has apertures formed in its upper region. Pins **23** fitted and fixed in these apertures function to connect the apparatus **1** to distal ends of the working arm **81** and the bucket link **82** so that the apparatus can swivel fore and aft relative to the distal end of said arm. An outer race **41** of swivel bearing is secured to the fringe of horizontal bottom **22** of bracket **2**, with the inner race **42** of said bearing being secured to the fringe of top plate **32** of frame **3**. A number of balls or short rollers are retained in between the outer and inner races to form the swivel bearing **4**, thus rendering these races **41**, **42** capable of relative rotation.

As shown in FIG. **1**, the motor **5** for swiveling the apparatus is fixed on and to the top plate **22** of the bracket **2**, and the pinion **44** is firmly secured to a projected portion of the motor's shaft **45**. This pinion **44** is in mesh with the circular rack **43** engraved in the inner race **42** as already mentioned above. Thus, the frame **3** is capable of rotation in unison with the crushing arms **33**, horizontally and relative to the bracket **2**.

The ports Ma and Mb of motor **5** are connected in fluid communication to branches **51** and **52** that diverge respectively from the internal paths **89**, **89** within the bracket. One of these branches **51** having the relieving throttle valve **53** disposed therein does continue to a first length of pipe that leads to the piston-side port of the cylinder **36**. In contrast, the other branch **52** having the check valve **57** disposed therein does continue to a second length of pipe leading to the head-side port of the cylinder **36**. The check valve **57** prevents the hydraulic fluid from flowing towards the motor **5**. The impacting-pressure bypassing means **54** that intervenes between the first and second lengths of pipe is located between the throttle valve **53** and motor **5**, from a first viewpoint, and also between the check valve **57** and motor **5**, from a second viewpoint.

The relieving throttle valve **53** is a circuit element that will not only inhibit the fluid from flowing through it if the pressure appearing upstreamly of the valve is lower than a threshold, but also restrict the flow rate of the fluid even if it is allowed to flow through the valve. For example, this valve **53** is a composite element as shown in FIG. **9** that is a combination of the variable throttle valve **75** with the variable relief valve **76** connected thereto in series. In an alternative example shown in FIG. **10**, the relieving throttle valve **53** is another composite element **53***a* consisting of the variable throttle valve **75** combined with a check valve **77** in series.

The impacting-pressure bypassing means **54** comprises a first and second parallel bypass lines that are spanned each between the branch **51** leading to port Mb and the other branch **52** leading to port Ma of the hydraulic motor **5**. The variable relief valve **55** disposed in the first bypass line permits the fluid to flow from the branch **51** to branch **52**, whereas the other variable relief valve **55***a* disposed in the second bypass line permits the fluid to flow from the branch **52** to branch **51**. By virtue of presence of such a means **54**, any impacting or extreme pressure appearing at either of port Ma or Mb will be relieved to the other port Mb or Ma, or vice versa.

MORE DETAILS IN OPERATION will now be given, denoting the circuit elements and portions with the reference numerals only and showing the order with arrow symbols (→). With the maneuverable control valve **86** shown in FIG. **1** being shifted to its parallel flow position, the hydraulic fluid from hydraulic source **88** will flow to→'P'→'A'→one **84**→one **85**→**89***b*→A1→A2→'C', in this order. On the other hand, the other flow of the fluid from the rod-side port 'R' of cylinder **36** will advance to→B2→B1→**89***a*→ the other **85**→ the other **84**→'B'→'T', also in this order, before returning into the tank 'TK'. Resultant extension of the piston rod of cylinder **36** will displace the crushing arms **33** towards each other so as to close them. With the maneuverable control valve **86** being shifted to its crossed flow position, the hydraulic fluid from hydraulic source **88** will flow to→'P'→'B'→the other **84**→the other **85**→ **89***a* →B1→B2→'R', in this order. On the other hand, the other flow of fluid from the rod-side port 'C' of cylinder **36** will advance to→A2→A1→**89***b*→the one **85**→the one **84**→'A'→'T', also in this order, before returning into the tank 'TK'. Resultant retraction of the piston rod of cylinder **36** will open the crushing arms **33** away from each other.

With the crushing arms **33** being kept full open as just mentioned, the pedal for actuating the maneuverable valve **86** may be held in a depressed state so as to continue fluid feed to the cylinder **36**. Consequently, hydraulic pressure will rise in the internal paths **89** and the branch **51** to exceed a limit that has been preset in and for the throttle valve **53**. As a result, the variable relief valve **76** (FIG. **9**) or the check valve **77** varying the cracking pressure (FIG. **10**) will open so that the feeding of fluid to the motor **5** will begin. The variable throttle valve **75** (FIG. **9** or **10**) regulates the flow rate of fluid thus being delivered to motor, so that it will not rotate at any undesirably high speed but will rotate at a moderate speed.

It will now be apparent that the hydraulic motor **5** swivels the crushing apparatus **1** to any desired angular position, and the power shovel body and its bucket link **82** are operable to cause the crushing apparatus to take any desired spatial posture. At the thus selected position and posture, the crushing arms **33** may be opened and closed to crush any concrete blocks or the like. The maneuverable valve **86** may be held in one of its states to further open the arms that have been opened fully, whereby the apparatus **1** will swivel further an angle to adjust its position. Even if any extremely high pressure would appear in either branch **51** or **52** when stopping the swiveling motion or during the crushing work, the impacting-pressure bypassing means **54** will instantly absorb such an extra pressure so as to protect the motor **5** from damage.

FIG. **2** shows a second embodiment, wherein the retarding means **60** is disposed in the branch **51** in order to delay or interrupt a while the feeding of hydraulic fluid to the motor **5** after the arms **33** have opened fully. This retarding means is interposed between the motor **5** and the relieving throttle valve **53**.

The switch-over valve **70** built in the retarding means **60** comprise a spool **61** that has an interrupting position at which the hydraulic fluid flow will be interrupted, and a through-flow position at which the fluid is allowed to pass through this valve. A spring **62** acting on one end of the spool **61** is biasing it always towards the interrupting position, and an urging means **65** having a pilot chamber **66** is disposed in contact with the other end of said spool. The urging means **65** is composed of a cylinder defining therein the chamber **66**, a piston **64** sliding in the cylinder, and a coiled spring **63** for urging the piston so as to discharge the fluid in the chamber **66**. Unless any positive pressure is present in pilot chamber **66**, the spring **63** will hold the piston **64** up a proper distance away from the said other end of spool **61**.

A side passage having a further throttle valve **68** does connect the inlet port of the switch-over valve **70** to the pilot chamber **66** in fluid communication. This chamber does also communicate with an upstream side of the first mentioned throttle valve **53** through a check valve **67**, in order to return to the branch an amount of fluid exuded from the pilot chamber.

If and when the composite relieving throttle valve **53** in the circuit of FIG. **2** is forced to open due to a positive hydraulic pressure of the hydraulic fluid, the switch-over valve **70** will be exposed to this pressure. Simultaneously, the fluid will flow through the throttle valve **68** into the pilot chamber **66**, so that the piston **64** is pressed downwards (in the drawings) for a time which the displacement of piston rod will take to bring its lower end into contact with the spool's upper end. Thus, the spool **61** will commence its downward motion to subsequently open the switch-over valve **70**, by shifting it to take a position where the hydraulic fluid can flow towards the motor **5**. Resultant rotations of this motor will drive the apparatus **1** to swivel its crushing arms **33**.

The retarding means **60** just discussed above may be designed such that its pilot chamber **66** is enlarged, with the gap between its piston **64** and spool **61** being increased and with the throttle valve **68** being narrowed. This design will be useful to prolong the delayed time which the switch-over valve **70** takes to come into its open position. In this way, any preferable length of time can be selected and employed between the preceding timing at which the arms **33** are opened fully and the succeeding timing at which they swing in unison. By virtue of this feature, it is possible to separately control the crushing operation and the swiveling motion of the arms, thereby rendering easier and more efficient the crushing works which the present apparatus has to do.

FIG. **3** shows a modification of the circuit comprising the retarding means **60** of FIG. **2**, wherein the impacting-pressure bypassing means **54***a* is of different structure from that **54** already described above. This means **54***a* comprises two fluid passages **107** and **108** both spanned between the branch **51** leading to port Mb and the other branch **52** leading to port Ma of the motor **5**. The first check valves **58** disposed in one of the passages **107** are arranged face-to-face so as to receive fluid flow from either branch **51** or **52**. The second check valves **48** disposed in the other passages **108** are arranged back-to-back so as to flow the fluid either into the branch **51** or **52**. A fluid communication path is connected to an intermediate point between the first check valves **58** and also to another intermediate point between the second check valves **48**. The variable relief valve **56** is disposed in this communication path, in such a direction that the fluid can flow in between the second valves **48**, from the higher-pressure zone appearing between the first valves **58**.

In the impacting-pressure bypassing means **54***a* as modified above, whether any hydraulic shock or abnormally high pressure acts on one port Ma or on the other port Mb, an excessive amount of fluid will be relieved via one of the branches **52** or **51** into the other of the branches **51** or **52**, through one of the check valves **58**, relief valve **56** and one of the check valves **48**. Thus, such an abnormal shock or pressure appearing at the one port is relieved toward the other port, also smoothly in this case.

FIG. **4** shows a further modification, in which the basic circuit of FIG. **1** is combined with a retarding means **100** of a different structure than that shown in FIG. **2**.

The retarding means **100** comprises a cylinder that preferably operates almost freely without suffering from any noticeable resistance. It has to operate otherwise against a reduced resistance at worst, and which resistance is to be considerably weaker than that acting against rotations of the motor **5** disposed in parallel with this retarding means.

Also in this case, the ports Ma and Mb are connected to the branches **51** and **52** that diverge from the respective internal paths **89***a* and **89***b* disposed in the bracket. One of the branches **51** communicates with one of the paths **89***a* for the piston-rod side of arm-closing/opening cylinder **36**, and a relief valve **110** and a throttle valve **111** are disposed in this branch **51**. Each of relief and throttle valves **110** and **111** is accompanied by a bypass line having a check valve **115** or **116** disposed therein, and each of these check valves allows the fluid to flow from the upstream side to the downstream side of the valve **110** or **111**.

The downstream side pipe of the throttle valve **111** diverges into two passages, one of them leading to the port Mb of motor **5**, with the other to a chamber 'A' of cylinder **100**.

The other passage from another chamber 'B' of cylinder **100** does directly communicate with the other path **89***b* extending from the cylinder-head side of arm-closing/opening cylinder **36**.

On the other hand, the other port Ma of motor **5** is connected to the other branch **52** diverging from said path **89***b* extending from the cylinder's **36** head side. The branch **52** has a checking relief valve **121** and an ordinary check valve **122**, both arranged in line in this branch. The ordinary check valve **122** inhibits the hydraulic fluid from flowing towards the motor **5**, but will not open to the path **89***b* until the pressure on its upstream side exceeds a limit in this embodiment. However, the checking relief valve **121** permits the hydraulic fluid to flow towards the path **89***b* away from the motor **5**, when the pressure on its upstream side exceeds the same or a different limit. A further check valve **125** bypassing the relief valve **121** allows the hydraulic fluid to flow towards the motor **5**.

In this embodiment, the passage extending from the chamber 'B' of the retarding cylinder **100** directly communicates with the path **89***b* for the cylinder-head side of cylinder **36**, as noted above. As the pressure in this side of cylinder **36** rises to close the arms **33**, the hydraulic fluid will be accumulated in the chamber 'B' of cylinder **100**.

In contrast with this, any ordinary crushing operation will never cause the fluid to flow into the other chamber 'A', since the other passage extending from this chamber 'A' of retarding cylinder **100** has the relief valve **110** disposed in said passage. Thus, normally only the chamber 'B' contains the fluid, with the other chamber 'A' remaining vacant to be ready for receiving the fluid as follows.

Similarly to the preceding embodiments, as the composite relieving throttle valve is opened to produce a fluid flow through the branch **51**, the fluid will preferentially enter the chamber 'A' of the retarding cylinder **100**. This is because this cylinder normally remains non-loaded, whereas a remarkable resistance is always acting against the motor **5** so as to render it 'loaded', viz., disable it to freely rotate. After the hydraulic fluid has saturated the chamber 'A', it will subsequently start to flow towards the motor **5**. By virtue of this feature, it is possible to suitably adjust time length from the full open of the arms **33**, **33** to the start of swiveling and to separately control the crushing operation and the swiveling motion of the arms, thereby rendering easier and more efficient the crushing works which the present apparatus has to do.

According to the hydraulic circuits employed in the foregoing embodiments discussed above, some of the constituent devices, parts or elements that have been necessary heretofore to the prior art piping for connecting the crushing apparatuses to any existing power shovel can now be dispensed with. Dispensable are: three pipe lines as the feed, return and drain paths for the power shovel, swivel-controlling valves and sub-circuits, swivel-actuating pedal and certain hoses for connecting the distal ends of pipe lines to a crushing apparatus. The piping cost will thus decrease to a remarkable degree, and further, only two connection hoses need to be attached to or detached from an existing power shovel joint within a much shorter time.

Each described hydraulic circuit for the crushing apparatus will enable any operator on a self-propelled working platform or truck to simply maneuver only the arm-closing/opening pedal, lever and the like whenever the apparatus has to be swiveled. The operator need not repeat to depress and release two or more pedals one after another when he or she swivels the crushing apparatus, thus saving his or her labor.

In the embodiments respectively shown in FIGS. **1** to **4**, the hydraulic motor **5** works to 'positively' swivel the crushing apparatus. However, the present invention may also apply to another system in which the crushing apparatus is kept pressed against a proper and neighboring foreign article while the shovel body is turning an angle. In this case, the apparatus will make a 'forced' or 'dragging' swivel as will be understood from the following additional embodiments described referring to FIGS. **5** to **7**.

A hydraulic circuit for the motor **5** in these additional embodiments is formed to be quite independent of the other circuit for closing/opening the crushing arms. The inlet and outlet port Ma and Mb are connected one to another through a bypass line **103**, which has a variable resisting means **104** and a fluid reservoir **14** disposed therein. This means **104** will operate for either port Ma or Mb that is then acting temporarily as the outlet port, and the reservoir **14** communicates with the temporary inlet port Mb or Ma. This circuit will apply the same moderate resistance to the motor **5**, whether it rotates in a forward or reversed direction, while automatically avoid any surplus of or deficiency in the hydraulic fluid resulting from change of conditions in each zone of the circuit.

Some examples of these variable resisting means and fluid reservoir will be given later.

Also in each of the crushing apparatuses shown in FIGS. **5** to **7**, the maneuverable control valve **86** may be operated in the same manner and to produce the same effect as noted in the preceding embodiments shown in FIGS. **1** to **4**. If it is shifted to its parallel flow position, then the fluid will flow from a hydraulic fluid source 'S' (**87**) and then to→'P'→'A'→**89***b*→A**1**→A**2**→'C', in this order. Such a flow will cause extension of the piston rod of the cylinder **36** so as to close the distal ends **34** of crushing arms of this apparatus. Simultaneously, the fluid will flow in a reversed direction from the rod-side port 'R' of cylinder **36** and then→B**2**→B**1**→**89***a*→'B'→'T', also in this order, before returning into the tank 'TK'.

With the maneuverable control valve **86** being shifted to its crossed flow position, the hydraulic fluid from hydraulic source will flow to→'P'→'B'→**89***a*→B**1**→B**2**→'R', in this order. On the other hand, the fluid returns from the rod-side port 'C' of cylinder **36** and advances to →A**2**→A**1**→**89***b*→'A'→'T', also in this order, before entering the tank 'TK'. Resultant retraction of the piston rod of cylinder **36** will open the distal ends **34** of crushing arms away from each other.

Any operator can optionally and easily close or open the crushing arm distal ends **34**, by means of the maneuverable control valve **86**.

To carry out a crushing work using the apparatus **1**, its crushing arms have to be opened at first, before the power shovel body is turned an angle while the arms' distal ends are kept in contact with a target article or portion to be crushed. This step is called 'butting-turn' that is effective to preliminarily adjust the direction in which the arms will then be closed and opened one or more times. Further, the bucket cylinder **83** will be operated to actuate the bucket link **82** so that extension or retraction of the piston rod of this cylinder does adjust fore-and-aft angle of crushing apparatus **1**, before placing its arms on the target article or portion. Subsequently, the crushing arms are closed towards each other to crushingly break said article or portion. The apparatus thus doing the crushing work will likely suffer from an angular torsion that is caused by an offset of the apparatus. However, the apparatus' body frame will make a forced swivel due to and in response to such an angular torsion so as to cancel it, thus spontaneously correcting the posture of said arms to swing in an accurate direction perpendicular to said target article.

If the 'butting-turn' or crushing operation results in a torsion forcing the apparatus' body frame to make a passive swivel, then the pinion **44** in mesh with the rack **43** formed on the inner periphery of the inner race of swivel bearing will actuate the hydraulic motor **5** to rotate. As a result, an amount of hydraulic fluid will be pushed into the bypass line **103** having the variable resisting means **104** installed therein. This means **104** cooperates with one of the motor's port Ma or Mb that is then acting temporarily as an outlet, so that resistance of a certain intensity will be produced against the motor whether it passively rotates clockwise or counterclockwise. A resultant negative torque which the motor **5** exerts will serve as a braking force acting on the crushing apparatus, so as to prevent the apparatus from swiveling freely.

Such an anti-swivel braking force will prevent the crushing arms from making any passive rotation that would otherwise be caused by the offset in gravitational center of said arms being closed or opened. Thus, the apparatus will maintain the swiveling angle preliminarily selected by the 'butting-turn', without showing any unallowable degree of rotation resulting from inertia.

The fluid reservoir **14** communicating with the bypass line will be useful to automatically compensate any surplus or deficiency that might appear due to the swiveling motion, any noticeable change in temperature and or any internal leakage of the fluid.

Now, some examples for embodying the combination of variable resisting means with the fluid reservoir will be described.

The bypass line **103** shown in FIG. **5** comprises a pilot switch-over valve **15** of the two-position four-way type, in which a parallel flow position and a crossed flow position are provided. This valve **15** will automatically detect which of the motor's **5** ports Ma and Mb is then acting as an outlet side (viz., higher-pressure side), with the other is acting as an inlet side. The bypass line **103** is composed of an exhaustion path and a return path, so that a variable relief valve **56** as the variable resisting means **104** is disposed in the exhaustion path to communicate with the higher-pressure side of motor **5**. A check valve is disposed in the return path to communicate with the lower-pressure side so as to allow the fluid to flow only towards the motor, and the fluid reservoir **14** intervenes between this check valve and the down-stream opening of said relief valve **56**. The fluid reservoir **14** is pressurized with a piston **108** urged thereto with a spring **109**, thereby imparting a proper moderate pressure to the interior of return path communicating with the lower-pressure side port.

In this circuit, a temporarily outlet-sided port Ma or Mb will impart a pressure (along a broken line) to a spool of the pilot switch-over valve **15** in either direction, when the body frame receives a torque to urge the motor **5** to rotate in either direction. The spool thus displaced will bring the outlet side port Ma or Mb into a fluid communication with the relief valve **56** disposed in the exhaustion path. Once the pressure from the outlet side port reaches and exceeds a preset value, the fluid will be relieved through this valve so as to let the hydraulic motor **5** rotate, imparting a braking force to the apparatus. The relieved amount of fluid will thus advance through the ports Q**2** and Q**1** of reservoir **14**, hence through the check valve **57** and the lower-pressure side port of switch-over valve **15**, until returning to the inlet side port of motor **5**.

Any surplus or deficiency of hydraulic fluid that may be caused by any change arising in the conditions of this circuit will be spontaneously canceled by the reservoir, and the biasing means installed therein will protect the motor **5** from cavitation that would result from its insufficient suction of fluid.

A bypass line **103***a* shown in FIG. **6** comprises two variable one-way resisting means **104***a* that are in fluid communication with the ports Ma, Mb, respectively. This means **104***a* is composed of a pair of variable relief valve **16***a* and check valve **67***a* arranged in parallel therewith. Each check valve **67***a* and **67***b* allows the fluid to flow only towards the motor. Both the relief valve and check valve in each pair lead to either port Ma or Mb, that is then standing on the inlet side or on the outlet side with respect to motor **5**. Distal ends of such means **104***a* communicate with each other through the fluid reservoir **14**. A piston **108** that is installed in the reservoir **14** and has a back urged forwards by a spring **109** will apply a proper pressure to the interior of this bypass line.

In this circuit, a temporarily outlet-sided port Ma or Mb will exert a positive pressure, when the body frame receives a torque to urge the motor **5** to rotate in either direction. Once the pressure from the outlet side port reaches and exceeds a preset value for the one-way resisting variable relief valve **16***a* or **16***b*, the fluid will be relieved through this valve so as to let the hydraulic motor **5** rotate, imparting a braking force to the apparatus. The relieved amount of fluid will thus advance through the check valve **67***b* or **67***a* of the one-way resisting means **57** so as to return to the inlet side port of motor **5**. Also in this case, any surplus or deficiency of hydraulic fluid that may be caused by any change arising in the conditions of this circuit will be spontaneously canceled by the reservoir. The biasing means installed therein will protect the motor **5** from cavitation that would occur due to its insufficient suction of fluid.

A further bypass line **103***b* shown in FIG. **7** has a pilot switch-over pilot valve **15***b* of the three-position four-way type installed therein. This valve **15***b* will automatically be shifted between its three positions, that is a neutral, a parallel flow and crossed flow positions. Similarly to the other circuit as summarized above, this valve **15***b* will also detect automatically which of the motor's **5** ports Ma and Mb is then acting as an outlet side (viz., higher-pressure side), with the other is acting as an inlet side. A variable relief valve **56** acting as the resisting means has an inlet port connected to a higher-pressure outlet port of the valve **15***b*. The outlet port of the relief valve **56** leads directly to the lower-pressure side return port of said valve **15***b*. Both the paths extending between this valve **15***b* and the motor **5** have branches **71** each acting as a replenishing path that leads to a fluid reservoir **14** arranged beside the said paths. The reservoir is pressurized with a piston **108** urged thereto with a spring **109**, thereby imparting a proper moderate pressure to the interior of return path communicating with the lower-pressure side port of the motor.

In this circuit, a temporarily outlet-sided port Ma or Mb will impart a pressure (along a broken line) to a spool of the pilot switch-over valve **15***b* in either direction, when the body frame receives a torque to urge the motor to rotate in either direction. The spool thus displaced will bring the outlet side port Ma or Mb into a fluid communication with the relief valve **56** disposed in the exhaustion path. Once the pressure from the outlet side port reaches and exceeds a preset value, the fluid will be relieved through this valve so as to let the hydraulic motor **5** rotate, imparting a braking force to the apparatus. The relieved amount of fluid will thus advance through the lower-pressure side port of the switch-over valve, returning to the inlet side port of motor **5**.

Any surplus or deficiency of hydraulic fluid that may be caused by any change arising in the conditions of this circuit will be spontaneously canceled by the reservoir through either replenishing path **71**. The biasing means installed therein will protect the motor **5** from cavitation that would result from its insufficient suction of fluid.

Generally, in operation of any crushing apparatus, its body frame will often be caused to swivel in order to protect it or the hydraulic power shovel body from any extreme twisting stress and strain that are likely to take place due to crushing motions. The apparatus must be maneuvered to take and keep its optimal position where it can crush a target article most efficiently. For this purpose, it should be prevented from making any unintended angular displacement that would be caused by interference with any obstacle or due to offset of its gravitational center. If the crushing arms have to change a direction in which they are closed or opened, then the power shovel body will be driven to make a 'butting-turn'. At this step of operation, the couple of crushing arms pressed against any pillar or wall are exactly displaced an angle to take their optimal posture or target position. During these steps of operation, the hydraulic motor **5** controlled in the manner detailed hereinbefore will inhibit the crushing apparatus from making any free and idle rotation. By virtue of the motor's stable and reliable braking force, all the operational steps can now be conducted smoothly and exactly.

The prior art braking systems such as the disc brake type do usually rely on mechanical friction. The loosening of a spring for urging a friction plate, the abrasion and rise in temperature thereof, any surplus or deficiency of lubricant oil as well as any foreign materials caught in the constituent parts, have often caused disorder in the braking mechanism. Therefore, frequent adjustment and/or repair of them have been unavoidable, though it requires mechanical skill to conduct very intricate, time-spending and labor-consuming works to be done in a narrow space. In view of these drawbacks in the prior art brakes, a variable resisting means including a relief valve or the like installed in line in a bypass line of hydraulic motor is provided herein to let the motor to generate a braking force so as to prevent its passive and excessive swiveling. The braking force can be adjusted exactly and easily by changing a hydraulic pressure acting in resisting means, being scarcely affected by any change in temperature that would impair stability and reliability of this system. No friction plate or the like that have shown quick abrasion is necessary any longer, thus the present braking system that need not be repaired for a long time is improved in durability. If hydraulic motors whose suction sides are of no positive pressure are forced to rotate, then the flow resistance inherent in the internal and upstream passages of said motors will produce a negative pressure therein. This problem is called 'cavitation' that will probably give the motors a serious damage, or break them. In order to avoid the 'cavitation' herein, the fluid reservoir has the compressing means incorporated therein and is installed in the bypass line connected to the hydraulic motor. This reservoir always applies a positive hydraulic pressure to the motor's suction side. Additionally, such a reservoir will also contribute to release of any braking heat, replenishment of fluid (to cover a leakage loss) and compensation of temporarily varying volume of the fluid (due to change in temperature). Thus an excellent braking mechanism that is capable of using an ordinary hydraulic motor as a braking means is achieved.

The invention claimed is:

1. A crushing apparatus that is attachable to a working arm of a self-propelled platform or truck, and that comprises crushing arms capable of being closed or opened by a hydraulic actuator as well as a swiveling mechanism having a hydraulic motor for driving the crushing arms to swivel, the crushing arms movable between a closed position and a fully open position;

the apparatus further comprising a branch diverged from a hydraulic fluid path communicating with the actuator for closing and opening the crushing arms, with this path feeding the hydraulic fluid to said actuator when the crushing arms are driven to open, and the branch having disposed therein an on-off means that normally keeps the branch closed, but will open this branch so as to drive the motor only when a pressure applied to the actuator rises above a predetermined level while the crushing arms remain opened, and a delay device incorporated in the branch such that when a pressure therein or in the hydraulic fluid path has exceeded a limit and a given period of delay time has lapsed, an amount of hydraulic fluid will be supplied to the swiveling mechanism after the crushing arms have fully opened.

2. A crushing apparatus as defined in claim **1**, wherein the delay device is an additional hydraulic cylinder connected in parallel to the hydraulic swiveling motor.

3. A crushing apparatus as defined in claim **2**, wherein the additional cylinder is actuated at a pressure lower than that at which the swiveling motor is actuated.

4. A crushing apparatus that is attachable to a working arm of a self-propelled platform or truck, and that comprises crushing arms capable of being closed or opened by a hydraulic actuator as well as a swiveling mechanism having a hydraulic swiveling motor for driving the crushing arms to swivel, the crushing arms movable between a closed position and a fully open position;

the apparatus further comprising in addition to hydraulic fluid paths respectively continuing to or from the actuator, branches diverged from the respective paths so as to communicate with the motor for swiveling the crushing arms, so that one of these paths will feed the hydraulic fluid to said actuator then the crushing arms are driven to open,

wherein one of the branches that is diverged from a hydraulic fluid path for feeding the hydraulic fluid to the actuator when the crushing arms are driven to open has disposed therein an on-off means that normally keeps this branch closed, but will open it so as to drive the motor only when a pressure applied to the on-off means rises above a predetermined level, whereas the other branch has a back-flow inhibitor disposed therein so that any amount of the hydraulic fluid cannot flow back towards the hydraulic motor; and

a delay device is incorporated in said one branch such that when a pressure therein or in the main hydraulic path has exceeded a limit and a given period of delay time has lapsed, an amount of hydraulic fluid will be supplied to the swiveling motor after the crushing arms have fully opened.

5. A crushing apparatus as defined in claim **4**, wherein the on-off means is composed of a relief valve and a throttle valve.

6. A crushing apparatus as defined in claim **5**, wherein the relief valve is adjustable as to its actuation pressure.

7. A crushing apparatus as defined in claim **4**, wherein the hydraulic motor is accompanied by an impacting pressure bypassing means.

8. A crushing apparatus as defined in claim **4**, wherein two ports are formed in the swiveling motor in order to charge it with the hydraulic fluid and also to discharge the fluid from the motor, and one, two or more bypass lines normally standing closed are formed between the two ports so that when one of the ports shows a pressure above a predetermined value, this port will come into a fluid communication with the other port of a lower pressure.

9. A crushing apparatus as defined in claim **4**, wherein two ports are formed in the swiveling motor as an inlet and an outlet for the hydraulic fluid, and each of two bypass lines respectively intervening between the two ports has relief valves that are installed in the respective bypass lines but in opposite directions, with a check valve being disposed beside and in parallel with each relief valve so as to constitute a sub-bypass in each bypass line.

10. A crushing apparatus as defined in claim **4**, wherein two ports are formed in the swiveling motor as an inlet and an outlet for the hydraulic fluid, two bypass lines and intervene between these ports, a couple of first check valves disposed in one of the bypass lines being arranged face-to-face, with a couple of second check valves being arranged back-to-back in the other bypass line and a relief valve connects a first intermediate point between the first check valves to a second intermediate point between the second check valves, so that an amount of hydraulic fluid will be permitted to flow from the bypass line to the other one when a pressure at the first intermediate point rises above a limit.

11. An attachment for use in a construction machinery and adapted for connection to a working arm mounted on a self-propelled working platform or truck having a hydraulic-pressure-generating equipment, the attachment comprising:

a swiveling mechanism such that a hydraulic swiveling actuator will rotate the attachment;

a branch diverging from a main hydraulic path connected to another hydraulic actuator so that the swiveling actuator receives hydraulic fluid through the branch;

crushing arms connected to the main hydraulic path and movable between a closed position and a fully open position;

an on-off means for opening said branch so as to drive the swiveling actuator only when a pressure in the main path rises above a predetermined level; and

a delay device incorporated in the branch such that when a pressure therein or in the main hydraulic path has exceeded a limit and a given period of delay time has lapsed, an amount of hydraulic fluid will be supplied to the swiveling motor after the crushing arms have fully opened.

12. An attachment as defined in claim **11**, wherein the attachment is a crushing apparatus having crushing arms, with the another actuator being an hydraulic cylinder that closes and opens the arms.

13. An attachment as defined in claim **12**, wherein the branch diverges from a portion of the main path feeding the hydraulic fluid to open the crushing arms.

14. An attachment as defined in claim **13**, wherein the swiveling actuator is a hydraulic motor.

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